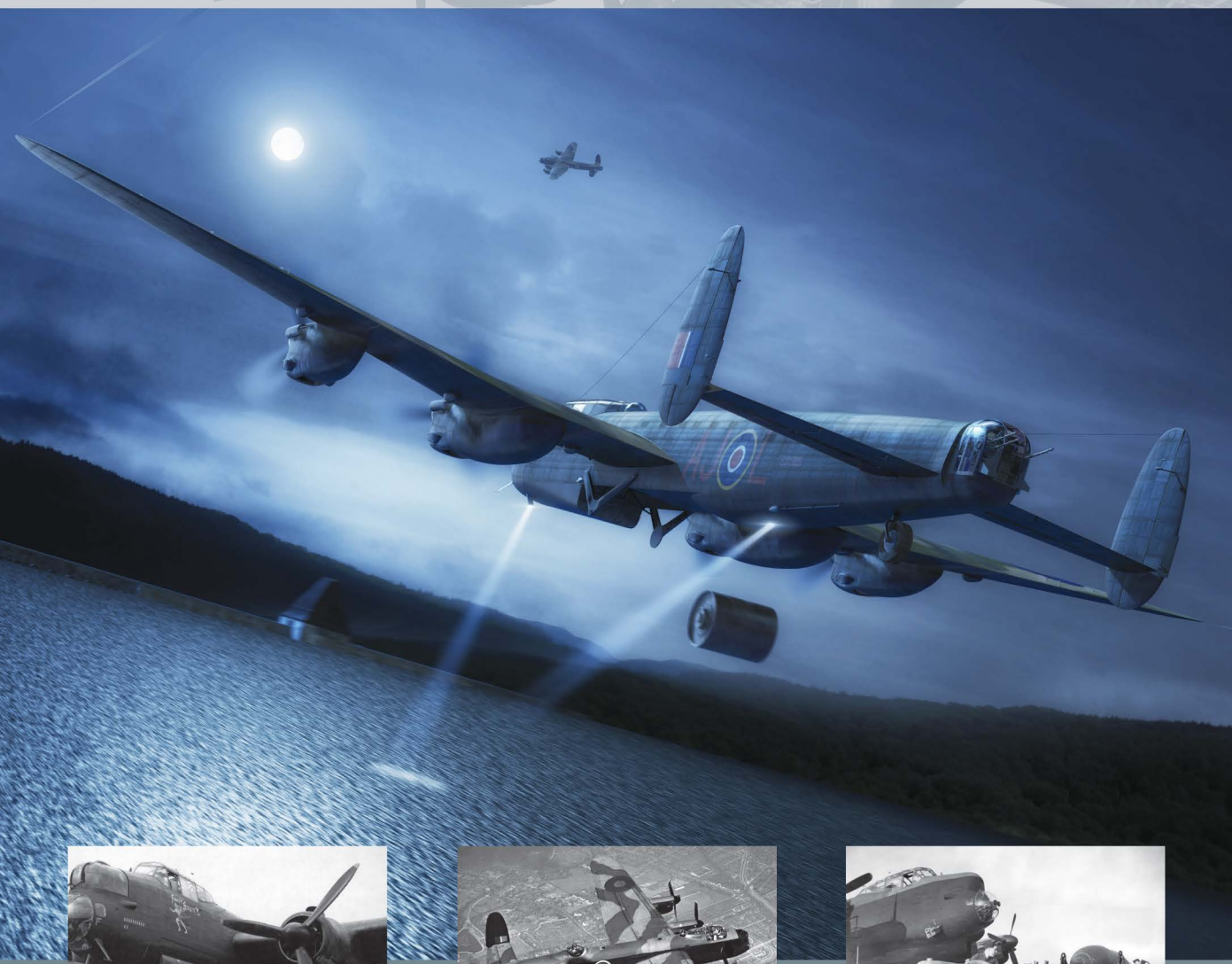
# AVRO LANCASTER



RICHARD MARKS

© Osprey Publishing • www.ospreypublishing.com

AIR VANGUARD 21

# AVRO LANCASTER

**RICHARD MARKS**

© Osprey Publishing • www.ospreypublishing.com

# CONTENTS


**INTRODUCTION** 4

**DESIGN AND DEVELOPMENT** 6

- The Manchester
- From humble beginnings
- A curate's egg
- Grounded
- Four engines
- The making of a legend
- A new bomber for the RAF

**TECHNICAL SPECIFICATIONS** 18

**THE LANCASTER: MARK BY MARK** 21

- Lancaster B. Mark I
- Lancaster B. Mark II
- Lancaster B. Mark III
- Type 464 'Provisioning' Lancaster
- Lancaster B. Mark X
- Lancaster B. Mark I Special
- Lancaster B. Mark VI
- Lancaster B. Mark I (FE)
- Lancaster B. Mark VII (FE)
- Lancaster A. S. R. /G.R./MR. 3
- Lancaster Mark I (modified)
- Lancaster B. Mark IV and B. Mark V
- Specialist equipment

**OPERATIONAL HISTORY** 43

- The Lancaster goes to war
- Augsburg, 17 April 1942
- The 'Thousand Bomber' Raids, May and June 1942
- The Pathfinders
- Operation *Chastise*, 16 May 1943
- Operation *Gomorrah*, July to August 1943
- A precision bomber

**CONCLUSION** 58

**FURTHER READING** 63

**INDEX** 64


© Osprey Publishing • www.ospreypublishing.com

# AVRO LANCASTER

## INTRODUCTION

The Avro Lancaster occupies a special place in the imaginations of many people and in the history of the Royal Air Force. It is seen as a key part of the strategic bombing offensive against the German and Italian war effort and is also associated with precision raids on targets as diverse as the Ruhr dams and the battleship *Tirpitz*. The Lancaster was undoubtedly a fine and capable aircraft but its development had an unpromising beginning.

The RAF's Bomber Command was formed in July 1936, as part of the expansion and reorganization of the RAF, in response to the instability in Europe and the threat of Nazi Germany. The Command inherited a generation of aging biplane aircraft. The day bomber force consisted of aircraft such as the Hawker Hart (introduced into service in 1932) and Westland Wapiti (introduced in 1929) which, even though extremely capable for their time, were almost obsolete by 1936. The heavy and night bomber force was no better off, managing with biplane bombers such as the Handley Page Heyford and the Vickers Virginia.

The Air Ministry and RAF had already realized the shortcomings of its equipment and in 1932 specification B.9/32 had been issued for a modern monoplane twin-engine, daytime medium bomber. In July 1934 the Air Ministry issued specification B.3/34 for a night-capable heavy bomber to replace the aging fleet of night bomber biplanes.

These new aircraft would join the force in the late 1930s, seeing the Command through the difficult first few years of World War II. Specification B.9/32 produced the sleek Handley Page Hampden and the business-like Vickers Wellington designed by Barnes Wallis. The Hampden entered RAF service in August 1938, capable of carrying a 4,000lb bomb load over 1,100 miles at a speed of 206mph, although it was lightly defended. The Wellington entered service in October 1938 and would become the RAF's most-produced bomber aircraft of the war. The Wellington was a tough aircraft due to Barnes Wallis's geodetic structure, and was capable of lifting a 4,000lb bomb load over 1,200 miles at a speed of 235mph. It was

Handley Page Hampden AT137 (UB-T) of No. 455 Squadron RAF in May 1942. The Hampden was one of the main types that equipped Bomber Command at the beginning of World War II, but soon proved to be obsolete.



© Osprey Publishing • www.ospreypublishing.com

Vickers Wellington IC. The Wellington served the RAF throughout World War II. The Wellington could carry a useful load, including the heavier 4,000lb high capacity 'cookie'.

also much more capable of defending itself, being equipped (after the very early Mark I) with two power-operated turrets armed with two .303 Browning machine guns in the nose and a sting in the tail of four .303 Browning machine guns.

The RAF received its first heavy bomber in March 1937 as a result of specification B.3/34. The Armstrong Whitworth Whitley was an angular, pugnacious-looking aircraft, which flew with a distinct nose-down attitude due to the main wing being given an 8.5 degree angle of incidence. This allowed for the lowest possible approach speed and landing run since flaps were out of favour when it was designed (even though production aircraft were equipped with hydraulically operated split flaps). The Whitley was capable of carrying a 6,000lb bomb load for 1,190 miles at a speed of 193mph. The main variant to see service, the Mark IV, was well armed with a single turret mounted Vickers .303 machine gun in a power-operated nose turret, and four Browning .303 machine guns in a power-operated tail turret. The Whitley would serve the RAF well, being the first British bomber to fly over Germany in World War II, the first to cross the Alps to bomb targets in Italy and the first to bomb Berlin. The aircraft also served with Coastal Command in the early battles against the U-boat menace in the Atlantic.

The Air Ministry knew that despite the great improvement the three new bombers offered the RAF, they were still only capable of carrying smaller bombs and had limited capability to match the RAF's strategic bombing mission, and so the search for a second generation of more-capable bombers was begun in 1936. A key figure in the development of the new strategic bombers was the Deputy Director of Plans at the Air Ministry, Group Captain (later Air Vice Marshal) Arthur Harris. Senior colleagues of Harris's favoured a mass of medium bombers, whereas Harris argued that only the 'heavy' promised the long-range and lifting power that he foresaw Bomber Command needing. Harris won and two specifications, B.12/36 and P.13/36, were issued. The former was for a bomber capable of carrying 8,000lb of bombs at 28,000ft with a range of 3,000 miles. This would result in the RAF's first four-engine heavy bomber, the Short Stirling, which entered service in 1941. The latter specification called for a high-performance heavy bomber capable of operating



© Osprey Publishing • www.ospreypublishing.com

from existing RAF airfields, with a load of 8,000lb of bombs or two aerial torpedoes, resulting in a large bomb bay, and it was to be powered by the new Rolls-Royce Vulture engines. Into the frame would step Roy Chadwick and his design team at A. V. Roe.

## DESIGN AND DEVELOPMENT

On 10 January 1910, Edwin Alliot Verdon Roe and Humphrey Verdon Roe established a company to build aeroplanes for the enthusiast in Manchester. The company was A.V. Roe and Company, commonly known as Avro. Shortly after its formation, a young aircraft designer introduced himself to Alliot Verdon Roe after serving his apprenticeship at the British Westinghouse Company in Manchester. He persuaded Roe to employ him, and by 1914, at just 21 years old, the young designer was in charge of a workforce of one hundred. The young man's name was Roy Chadwick, who would be instrumental in the design of the Avro 500 series of aircraft, which included the 504, an aircraft that became the mainstay of RAF pilot training until the 1930s. He was also responsible for the creation of the Lancaster and Vulcan for Avro.

In 1914, Roy Dobson joined Avro and by 1918 was works manager, beginning a long working relationship with Chadwick. Dobson was appointed general manager of Avro in 1934 and managing director in 1941. Avro was sold to J. D. Siddeley in 1928, and Chadwick was appointed chief designer, eventually becoming a company director in 1936. Dobson and Chadwick continued to work closely together, Chadwick concentrating on aircraft design and Dobson overseeing production. The pieces were now in place for the creation of the Lancaster family of aircraft.

### The Manchester

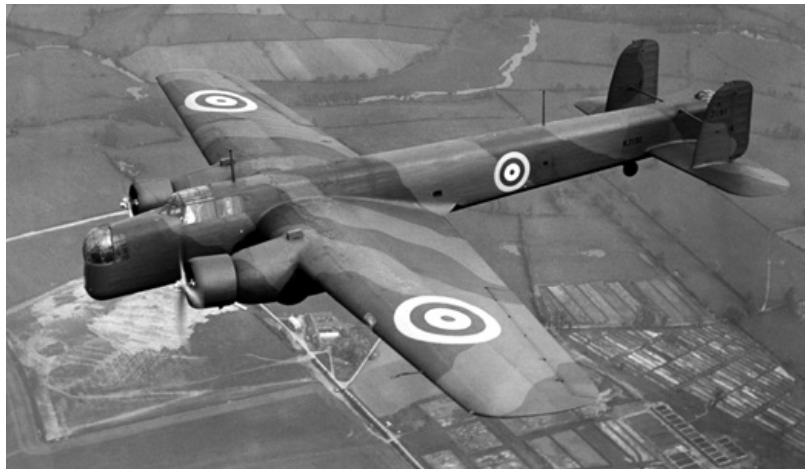
The Air Ministry specification P.13/36 was issued in September 1936 to address Harris's requirement for a high-performance heavy bomber. The specification called for a crew of six, introducing new and more specialized roles for the first time, which consisted of two pilots, a specialized navigator, bomb aimer, wireless operator and air gunner. The design requirement also called for two power-operated turrets in the nose (two guns) and the tail (four guns), a range of not less than 2,000 miles at a speed of not less than 275mph at 15,000ft, and a load of either 8,000lb or two aerial torpedoes, which required the design of a large bomb bay. The specification also called for interchangeable bomb and fuel configurations to give greater operational flexibility.

The decision was taken at the Air Ministry to include two very-high-performance engines in preference to four of the existing power plants then available in the 800 to 1,000hp category, and the new Rolls-Royce Vulture was selected. The Vulture consisted of two sets of Peregrine V12 cylinder blocks mounted together to use a common crank shaft, resulting in a 24-cylinder engine of X cross section. The Vulture gave a high power-to-weight ratio and was less costly than four engines. Rolls-Royce began design work in 1935, the engine first being tested in 1937, and by August 1939 the Vulture II engine was producing a promising 1,800hp. The engine was not perfect,



© Osprey Publishing • www.ospreypublishing.com

suffering from connecting rod failures that required a reduction in engine speed, although despite this the engine still produced promising results. In service, the engine would develop a habit of catching fire in flight, an issue which would continue to plague the engine throughout its service life, much as the double-engine power plant in the German Heinkel He-117 would do later. The Vulture engine would develop a number of other problems in service, which would result in deplorable reliability, but nevertheless the engine was persevered with and designs were submitted to meet the specification.



Armstrong Whitworth Whitley K7191. The Whitley was Bomber Command's first heavy bomber and the first to bomb Berlin and Italy. Its limited bomb-carrying capacity and slow speed saw it phased out of Bomber Command as the new generation of heavy bombers began to arrive.

A number of companies entered bids for P.13/36. Bristol Aeroplane Company submitted a design for a shoulder wing monoplane capable of carrying an 8,000lb load and achieving 315mph, but that used a pair of Bristol Hercules radial engines. The design was rejected, as was a design submitted by Hawker for a mid-wing monoplane using two Vulture engines.

Handley Page submitted a design intended to be fitted with two Vulture engines. The H.P.56 was redesigned to be fitted with four Rolls-Royce Merlin engines once concerns about the viability of the Vulture arose. The design would become the H.P.57, later named the Halifax.

The last design standing was Avro's submission, the Type 679, first submitted in September 1936. It was for a twin Vulture layout with a 69ft-long fuselage coupled to a 72ft wing that tapered in plan form and thickness toward the wing tips, with a tail unit consisting of twin fins and rudders. The front crew was accommodated forward of the main spar, where positions were provided for two pilots, a navigator/bomb aimer, and a wireless operator/front gunner. The remaining two crew members were both air gunners and were positioned aft of the main spar in the ventral and tail turrets. The specification also called for Chadwick's team to produce an airframe the like of which they had not produced before, requiring a novel configuration, stressed skinning and of a weight and power not yet attempted. The Avro 679 was the last design remaining in the running and in September 1936, the Air Ministry invited Avro to build two prototypes, L7246 and L7247, to be called the Manchester.

## From humble beginnings

The first prototype Manchester, L7246, was built at Avro's Newton Heath factory, the main sections being transported to Ringway airfield for assembly during May 1939. The first prototype was not fitted with turrets, the spaces being faired in for flight testing. The Manchester first took to the air on 25 July 1939, with Avro's chief test pilot Captain H. A. 'Sam' Brown at the controls, but all was not well. The aircraft exhibited a number of handling faults, including an issue with lateral stability and difficult handling caused by high wing loading. The Aeroplane and Armament Experimental Establishment



© Osprey Publishing • www.ospreypublishing.com

(A&AEE) at Boscombe Down made similar observations when they received L7246 for RAF evaluation. The tests also revealed that the Vulture Mark I engines were limited in boost and lacking power. Despite the teething troubles the design was generally praised, particularly with reference to speed and altitude performance. The Manchester was also viewed as being a big step forward in bomber design despite the issues with its power plants, which, it was hoped, would be resolved by the unrestricted engines intended for the second prototype.

Despite its shortcomings, events in Europe and the immediate threat of war resulted in plans for mass production of the Manchester being put into place before either prototype had flown. It was to be produced at the Avro plants at Newton Heath and Woodford, as well as the Metropolitan Vickers plant at Trafford Park, Manchester in 1938.

The second prototype, L7247, differed from its predecessor in having a redesigned and extended outer wing and new fins and rudder. L7247 made its maiden flight on 26 May 1940 and whilst generally successful, the problem with lateral stability remained. The airframe was modified almost immediately, with the addition of a shark-like third fin above the centre of the rear fuselage to resolve the problem. Further modifications were made to L7247 throughout 1940, including the fitting of improved Vulture II engines, a larger central fin, and hydraulically powered Fraser Nash turrets in the nose, tail and ventral positions. The ventral turret became a cause for concern since when lowered it produced enough drag to slow the aircraft by 15 knots. The 'dustbin', as it became known, was also heavy and crude.

Production contracts were awarded for an intended 1,200 Manchesters. The first contracts were awarded to Avro at Newton Heath in Manchester, under Contract B.648770/37, for an initial run of 200 airframes, and Metropolitan Vickers at Trafford Park in Manchester, under Contract B.108750/40, for 100 airframes, later expanded to include a further 300 airframes to be built by the Fairey Aviation Company and Sir W. G. Armstrong Whitworth and Co. The first production aircraft, L7276, was delivered to the A&AEE on 5 August 1940.

A

**1: AVRO MANCHESTER MARK IA (NO. 50 SQUADRON)**

L7301 (VN-D) was flown by Flying Officer Leslie Manser and his crew during the first 'Thousand Bomber' raid on Cologne during the night of 30 May 1942. Manser's aircraft was badly damaged by flak over the target and struggled to remain airborne. Manser ordered his crew to abandon the aircraft while he tried to keep it airborne. Manser remained with the aircraft and was killed when it crashed near Bree in Belgium. Manser was awarded a posthumous Victoria Cross for his actions.

**2: AVRO LANCASTER B. MARK III (NO. 44 [RHODESIA] SQUADRON)**

ND578 (KM-Y) completed her 107th mission during January 1945 and had completed 123 operational missions by April 1945, eventually being retired late in that year. The card in the cockpit window was borrowed by the crew from London Zoo and reads 'These Animals are Dangerous'.

**3: AVRO LANCASTER B. MARK III (NO. 75 SQUADRON)**

ME321 (AA-N) was flown by Flight Lieutenant Harry Yates DFC and his crew until they completed their tour of operations on 31 December 1944. ME321 was shot down by a night fighter over Holland the following night.

**4: AVRO LANCASTER B. MARK I (NO. 300 [MASOVIAN] SQUADRON)**

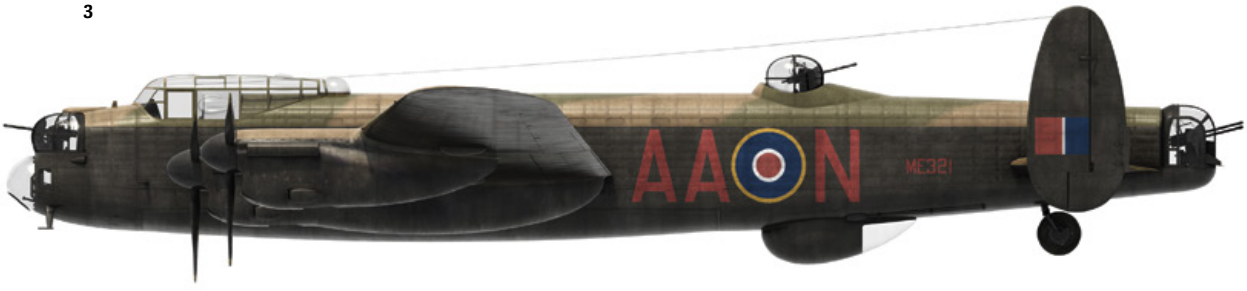
LL807 (BH-N), flown by Flying Officer J. Rosanski, carries a small Polish air force marking under the cockpit. No. 300 Squadron was a free Polish unit based at Faldingworth in Lincolnshire.

© Osprey Publishing • www.ospreypublishing.com

1

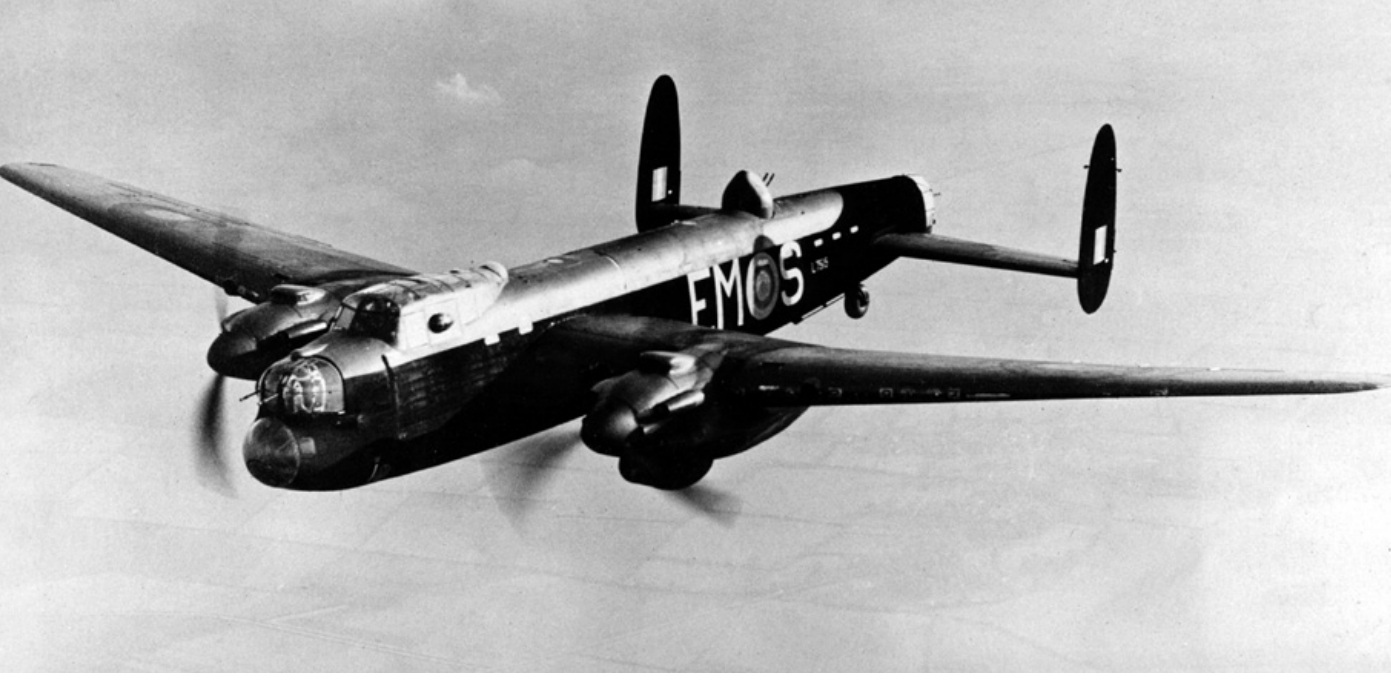
2

3




4

© Osprey Publishing • www.ospreypublishing.com




Avro Manchester Mark I, L715 (EM-S), of No. 207 Squadron, which was the first to receive Manchesters. The first arrived on 10 November 1940. L715 clearly shows the Vulture engines and also the tail assembly after removal of the central fin.

## A curate's egg

The Manchester I was good in parts, but would be plagued by faults with the Vulture engines. After the summer of 1940 and the exploits of 'The Few' in the Battle of Britain, it appeared that Britain was safe from invasion for the time being. Thoughts at RAF High Command started to swing from defence to attack. The new Manchester appeared clearly to offer the chance not only to take the war to Germany, but to take it right into its heartland, which the shorter-ranged medium bombers struggled to reach. The RAF and Avro believed that there was not enough time to develop the new aircraft further and that it should enter service as soon as possible. The urgent need to strike back at Germany was coupled with a general feeling that 'everything would be all right' after trials with the Manchester suggested that the aircraft would be successful, and so mass production began. The Manchester was rushed into service albeit with new Vulture Mark II engines, which whilst a definite improvement on the original Vulture still lacked power and were prone to overheating and fire.

The first Manchesters reached No. 207 Squadron, which had reformed at RAF Waddington on 1 November 1940 under Squadron Leader Noel Hyde. The squadron was made responsible for bringing the new aircraft up to operational standard by developing crew training regimes and new tactics. The squadron was part of No. 5 Group Bomber Command under Arthur Harris, whose fate seemed once again entwined with the Lancaster family. The first Manchester, L7279, was delivered to 207 Squadron on 6 November, and over the next six weeks the squadron's strength reached 11 aircraft and 16 crews, including some of Bomber Command's most experienced airmen.

The entry of the aircraft into operational service, however, was delayed once again by technical faults with the Vulture engines and issues with the airframe. These were overcome and the Manchester undertook its first operations on the night of 24 February 1941. Six aircraft took part in the raid on Brest in France where the German cruiser *Admiral Hipper* had been reported. Despite the Manchesters performing as expected, the ship was not hit or damaged. The aircraft had taken part in operations just 18 months after



© Osprey Publishing • www.ospreypublishing.com

the prototype had flown for the first time and the career of the Lancaster family had begun.

Despite this initial 'success', the early aircraft that were delivered to squadrons were early Mark I airframes that had the original triple tail fin arrangement, no dorsal turret and were unable to carry the 2,000lb bomb that had been one of the early design advantages of the aircraft over its competitors. The problem was quickly resolved and within a month of commencing operations No. 207 Squadron began to receive slightly updated Mark I airframes, which included a number of improvements including the addition of a dorsal Nash & Thompson FN7 turret mounting two Browning .303 machine guns. Even the arrival of the improved Mark I did not resolve the issues with the engines, however. No. 207 Squadron suffered its first loss on the night of 20th March when L7278 crashed following an engine fire on take-off, killing both pilots and two of the crew.

Despite its shortcomings, a second squadron was formed and equipped with the Manchester the day after 207's first operational sortie. No. 97 Squadron was formed at Waddington under Squadron Leader Denys Balsdon and undertook its first operation on the night of 8 April, when four of its Manchesters took part in a raid against Kiel. All four of No. 97 Squadron's aircraft returned safely, but on the same night a Manchester of No. 207 Squadron commanded by Noel Hyde (recently promoted to wing commander) failed to return. The loss of Wing Commander Hyde's aircraft was seen as a setback to the Manchester's early operational career, since he had been instrumental in bringing the aircraft to operational readiness.

## Grounded

Despite the new engines and changes to the airframe, the issues with the Vulture persisted, and by April 1941 enough operational hours had been flown on the type to enable detailed analysis of the engine's capabilities and weaknesses to be undertaken. Close examination of stripped down Vulture engines revealed that the overheating problem was being caused by the X arrangement of cylinders, which restricted cooling and affected lubrication of the big-end bearings. A decision was taken on 13 April 1941 to ground all Manchesters until such time as a solution to the problem could be found.

Whilst the aircraft were grounded, the Avro engineers took the opportunity to make design changes to the existing Manchesters to bring them closer to the design specification, among which were the general adoption of the dorsal turret and changes to the bomb bay to allow the aircraft to carry the larger 4,000lb bomb (Avro Mod.232).

The aircraft was finally released back into service following changes to the engine, and on the night of 2 May the Manchester resumed operations. One of No. 207 Squadron's aircraft was the first Manchester to drop the new 4,000lb 'cookie' on a target. Although the bomb had already been dropped by Wellington

Avro Lancaster undercarriage assembly. This Lancaster of No. 44 Squadron is having its main wheel refitted. The undercarriage assembly is the same as that fitted to the Manchester.



© Osprey Publishing • www.ospreypublishing.com

A WAAF works on the equipment in the bomb aimer's position of a Lancaster. The gangway into the nose section is fitted with handrails to assist the crewman. The panel directly above the WAAF is the rear of the front turret fairing; when the turret was manned the gunner's legs would dangle into the space occupied by the WAAF, the turret having no bottom.

crews, it was now also available to Manchester units. The Manchester soldiered on and by the end of May 1941 had flown 100 operational sorties.

It is difficult to assess the effectiveness of the new aircraft during its first three months of service. The aircraft had suffered setbacks and losses, but it can be argued that this was only to be expected in the introduction of a new aircraft type into operational service. Analysis is also made more difficult by the problems of assessing how losses occurred, especially over hostile territory. Even so it is clear that the unreliable Vulture engines were the reason for many aborted sorties, the abort rate being as high as one in five aircraft during the first three months of its service. It also appears that more Manchesters were lost as a result of technical failure than as a result of enemy action. The issues with the engines continued and the Manchester was once again grounded on 16 June, returning to service six days later. A week after that, all Manchesters were once again grounded for 'engine overhauls'.

The issues with the unreliability of the engines continued, and unserviceability had become so serious by July 1941 that the Manchester squadrons had been forced to make use of obsolete Hampden bombers to make up the numbers required for operations. The Manchester was gaining a reputation for unreliability and doubts were beginning to be expressed about its future. After much discussion in the higher echelons of the RAF it was decided to persevere with the aircraft, but with a number of modifications. The central fin was to be removed and the size of the tail plane and the two remaining fins was to be increased to improve lateral stability. The improved Manchester was designated the Mark Ia.

Whilst the changes were being made, a new squadron was formed and equipped with Manchesters, No. 61 Squadron forming at North Luffenham on 17 July. Manchester operations recommenced on the night of 7 August, and throughout the remainder of 1941 Manchester units continued working up new crews, gradually increasing the number of Manchester sorties. A fourth unit, No. 83 Squadron, began re-equipping with the Manchester at Scampton in December 1941, commencing operations in January 1942. Despite this increase in effort, the Manchester's contribution to Bomber Command's efforts remained small. Its introduction to service was frustratingly slow, leaving the main workload to other types. Even though the aircraft had been in service for some ten months, the number of operational aircraft and crews was still extremely small, and by the end of 1941 there were only four operational Manchester squadrons (7 per cent of Bomber Command's total strength) as opposed to 21 operational Wellington squadrons, which still formed the backbone of the Command's strength. On 7 September 1941, Bomber Command sent 198 aircraft to Berlin, only four of which were Manchesters,



© Osprey Publishing • www.ospreypublishing.com

and on 7 November the entire serviceable strength of Bomber Command was sent to Berlin, only 15 of which were Manchesters.

Despite its now obvious failure, the RAF was forced to persevere with the type in late 1941 as there were no alternatives. The Short Stirling was beginning to look doubtful and the Handley Page Halifax was still unproven and only equipped a handful of units. The only other option open to Bomber Command was to re-equip the Manchester units with Wellingtons and obsolete Hampdens, but this would have been a backward step. Something needed to be done to solve the Manchester's faults.

## Four engines

The unsatisfactory performance of the Vulture engines had convinced the design team at A. V. Roe to consider replacing them with either two Bristol Centaurus radial engines or two Napier Sabre I inline engines. One Manchester airframe was sent to Napier in Luton for Sabres to be installed, but as it became clear that the Sabre would require lengthy development it was discarded as an option for improving the Manchester. Two Bristol Centaurus engines were fitted to a Manchester test airframe, which was designated the Manchester Mark II. The Centaurus was a more powerful development of the Bristol Hercules engine fitted to the Short Stirling, but despite the promise the engine and airframe combination appeared to offer, the Manchester II never flew, being superseded by the extremely promising Manchester Mark III.

Roy Chadwick had been considering the possibility of adapting the Manchester to accommodate four engines before the war, as soon as it became obvious that the Vulture engine was going to result in the Manchester being underpowered. Chadwick also thought that the four-engine Stirling and Halifax being developed alongside the Manchester would offer increased range and improved bomb load as well as greater potential for future development. The Manchester, despite its faults, was basically a good design that offered one distinct advantage over the other types, namely that it had been designed from the outset with a large bomb bay.

The power-plant issue occupied the team at A. V. Roe and various options were discussed for the four-engine Manchester III. The Bristol Taurus and Bristol Pegasus were discarded fairly quickly, as Chadwick believed that the most sensible choice was to fit the Mark III with four of the proven Rolls-Royce Merlin engines (as fitted to the early Halifax) or four Bristol Hercules engines (as fitted to the Short Stirling). One immediate impact of fitting two additional engines was an increase in weight by 12.5 per cent over the Manchester I for the Merlin option, and a further 1,000lb for the Hercules option. In order to support the

Armourers refitting Browning machine guns to a Lancaster tail turret. The Manchester and Lancaster shared the same defensive weapons. The Browning .303 machine gun was the standard weapon used on Bomber Command aircraft during World War II. The armourer in the turret is sitting in the gunner's entry doorway.



© Osprey Publishing • www.ospreypublishing.com

RAF fitters working on Merlin engines. The two starboard Merlin engines of this Lancaster are uncowled for maintenance. The Merlin engine would be fitted to all marks of Lancaster with the exception of the B. Mark II.

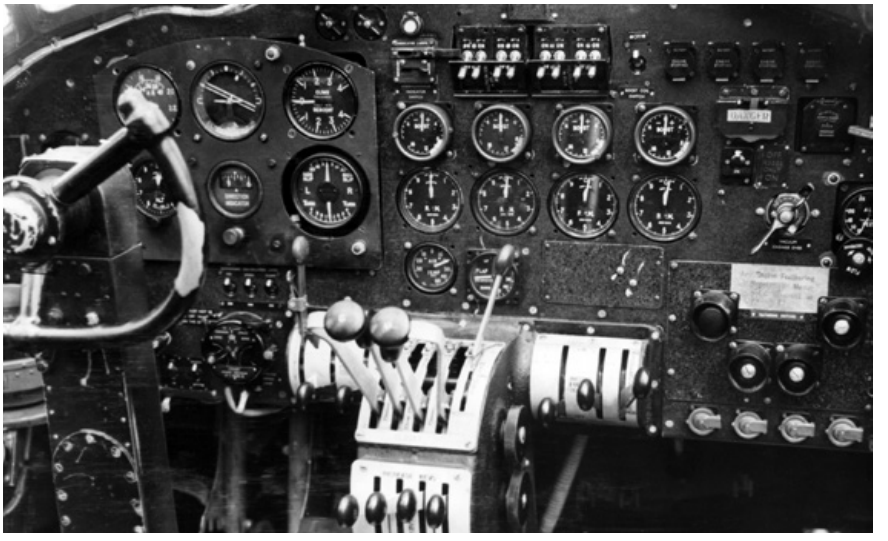
increased weight, Chadwick and the design team at A. V. Roe considered strengthening the undercarriage and changing the tail assembly.

The proposal for the four-engine Manchester was designated the Avro Type 680, but was not considered a serious competitor to the other two four-engine bombers then in development until a new specification was issued by the Air Ministry. Specification B.1/39 was issued on 6 March 1939 as a result of work undertaken by the 'Bombing Committee'. The specification called for a four-engine bomber with a maximum all-up weight of 50,000lb, including a bomb load of 1,000lb and two cannon armed turrets. The new aircraft was to have a crew of seven and be capable of an operating range of over 2,500 miles at a cruising speed of 250mph at 15,000ft. Sholto Douglas, the Assistant Chief of Air Staff (ACAS), insisted that the project should be progressed as a matter of urgency and several designs were considered. The designs included proposals from Armstrong Whitworth (A. W. 58), which suffered from cramped crew accommodation, Bristol (Bristol 159), which had issues due to its two-tier bomb stowage, Handley Page (H. P. 60), which suffered from poor crew accommodation, Shorts (S.34) and Vickers (Vickers 405), both of which were disliked due to issues with their defensive armament, and the Avro 680. The Air Ministry believed that the Handley Page and Bristol proposals had the most promise and four full-scale prototypes were ordered in late December 1939. The Avro Type 680 was not to be proceeded with.

Avro Type 683 Lancaster Second Prototype (DG595). The second prototype first flew on 13 May 1941. The aircraft was as close to production standard as possible. DG595 is equipped with the FN64 ventral turret seen below the fuselage beneath the mid-upper turret.

However, events would transpire to bring the Avro offering back to the table. In May 1940 Air Vice Marshal Tedder wrote that the four prototypes for the B.1/39 'Ideal Bomber' project should be suspended amid concerns about proceeding with such an advanced aircraft, and in July Handley Page and Bristol were informed that design work should cease. The German advance into France convinced the Ministry of Aircraft Production that production should be concentrated on certain types of aircraft, and the 'Ideal Bomber' was retired to obscurity. The RAF then removed the restriction that had plagued the earlier bomber designs, which dictated that all new bombers must be able to operate from existing RAF airfields. This opened the doors for Chadwick to design an aircraft with a longer and thinner wing made of stronger materials and capable of taking four

© Osprey Publishing • www.ospreypublishing.com



Avro Lancaster cockpit. The central console that holds the engine controls is clearly visible in this image. The top bank of controls is the throttles, the lower bank is the propeller control levers. The panel of six instruments in front of the control column is the RAF's standard cluster of Air Speed Indicator, artificial horizon, climb indicator, altimeter, compass and turn indicator.

engines. The Avro Type 683 was now born. The aircraft was to be powered by four Rolls-Royce Merlin X engines, with increased wingspan over the Manchester Mark I and an enlarged tail plane.

The outbreak of war in 1939 resulted in Avro concentrating on bringing the Manchester into RAF service, but the four-engine Manchester continued to be developed at A. V. Roe as a separate project under Stuart Davies. The Type 683 project revealed that the aircraft would exceed the performance laid down in the specification, giving an improved operating speed, altitude and bomb capacity. A. V. Roe had always believed that the Manchester would eventually be replaced by a four-engine bomber, and the thought that this might be the Halifax or Stirling models was cause for concern. The designers at A. V. Roe believed that the more sensible option was for the Manchester to be replaced by a four-engine variant to ensure commonality of parts and training. Once the Manchester I had been launched into service, the team at A. V. Roe gave greater priority to the Type 683, although the project almost stalled once again.

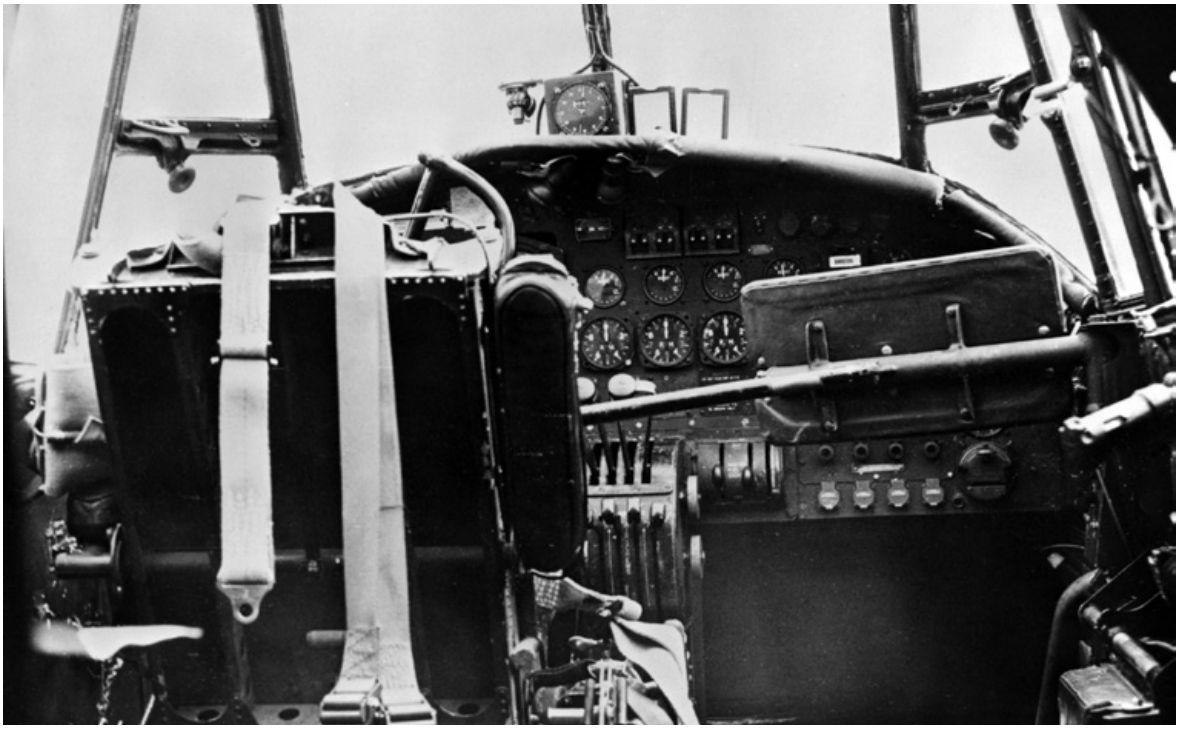
The issues with the Manchester had convinced the Ministry of Aircraft Production that the A. V. Roe production facilities should be turned over to Halifax production. Within hours of receiving notification that this might be the case, Roy Chadwick and Roy Dobson went to the ministry with full performance estimates for the Type 683 and persuaded them to order two prototypes to be produced by July 1941. In fact a contract was awarded for four prototypes of a four-engine bomber to replace the Manchester. The first was to feature a modified Manchester fuselage powered by four Merlin X engines, the second was to be representative of the final production airframe and the third was to be fitted with four Bristol Hercules engines, while the fourth prototype was never built. Chadwick and Dobson had earned a reprieve and the Manchester Mark III was born.

## The making of a legend

Authority to go ahead with the four prototype Manchester III airframes was given to A. V. Roe on 19 November 1940. In order to save time, a Manchester Mark I airframe, BT308, was taken off the production line and fitted with four



© Osprey Publishing • www.ospreypublishing.com



General view of the Lancaster cockpit. The pilot's seat is at the extreme left, the fold-down second pilot's seat to the right. The dark area at the bottom right leads to the bomb aimer's position and the front turret.

Merlin X engines to become the first prototype Manchester III. A. V. Roe experienced some difficulty in getting supplies of Merlin engines due to the Ministry of Aircraft Production's determination that all Merlin production should be reserved for desperately needed Spitfire and Hurricane production, but Chadwick and Dobson acquired four engines for BT308 from a close friend at Rolls-Royce. Yet another obstacle in their path had been overcome. Chadwick and Davies then agreed that BT308 should remain a standard Manchester fuselage assembly but that the wings would be modified with new outer wing and power-plant assemblies. The aircraft would retain the standard Manchester undercarriage and electrical system powered by the inner engines, but would have a larger 33ft tail plane with standard Manchester fins. BT308 would also retain the third central fin on the rear fuselage section. The inner engines were located at the same points on the wing but in redesigned fairings to accommodate the new engines. The outer engines were fitted in locations determined by the diameter of the propeller arcs, but as far inboard as was possible. The cockpit of BT308 retained a similar layout to production Manchester Mark Is, but with a wider centre console to accommodate the four engine throttle levers side by side, with the propeller controls mounted underneath as opposed to their position alongside the throttle in the Mark I. All flight instruments remained the same as for a Mark I other than the increased instruments for the additional pair of engines.

BT308 was completed and transported to Ringway (now Manchester International Airport) for its first flight, which was delayed by changes to the hydraulic system and fog. The flight took place on 9 January 1941 with A. V. Roe test pilots 'Sam' Brown and Bill Thorn at the controls. The flight was successful, and nine more test flights followed in quick succession before BT308 was handed over to A&AEE at Boscombe Down on 27 February for intensive flight trials.



© Osprey Publishing • www.ospreypublishing.com

Meanwhile, it had been decided at A. V. Roe that the new bomber should adopt a new name. The designers had informally christened the project with the name 'Lancaster' and used that name for some time when referring to the Type 683, although the term had not been recognized by the Air Ministry. On 28 February 1941 the name was formally approved and the new aircraft was officially christened. A legend had arrived to take its place in aviation history.

## A new bomber for the RAF

After trials at A&AEE, BT308 arrived back at A. V. Roe to be fitted with a new tail section, including the removal of the central fin. The trials at Boscombe Down had proved successful, with only slight directional stability issues being reported, and it was expected that these would be solved by the new tail assembly. After modification BT308 returned to Boscombe Down for preliminary service evaluation and in September 1941 it was delivered to RAF Waddington for familiarization and crew training.

Meanwhile the second prototype, DG595, made its maiden flight of 20 minutes on 13 May 1941. DG595 was built to be as close as possible to production airframes. It was stressed to the maximum production weight of 60,000lb all up and was capable of carrying a full war load, including the addition of Nash and Thompson FN50 dorsal and FN64 ventral gun turrets. DG595 was powered by four Rolls-Royce Merlin XX 12-cylinder, 60-degree upright vee, liquid-cooled inline engines with single-stage centrifugal superchargers. The third prototype, DT810, made its first flight on 26 November 1941, by which time the first production Lancaster Mark I had already flown. DT810 was, according to the initial order, to be the prototype Lancaster Mark II. It was powered by four Bristol Hercules VI air-cooled, two-row, 14-cylinder, sleeve-valve radial engines with two-speed centrifugal superchargers. The fourth prototype, DT812, was never built.

In anticipation of the Lancaster being successful, the original production order for 1,200 Manchesters was amended. The contract awarded to A. V. Roe at Newton Heath was altered so that the first 157 aircraft would be completed as Manchester Mark I/Ia airframes, the remaining 43 as Lancasters. The contract awarded to Metropolitan Vickers for 100 Manchesters required the first 43 to be completed as Manchester Mark I/Ia, while the remaining 57 aircraft were to be completed as Lancasters. The initial orders for Fairey Aviation and Sir W. G. Armstrong Whitworth and Co. for 300 Manchesters were cancelled.

ATA Pilot Mrs Ruth Moore performs pre-flight checks on a new Lancaster. The ground crewman is standing in the well leading to the steps into the bomb aimer's position.



© Osprey Publishing • www.ospreypublishing.com

In order to co-ordinate Lancaster production across different factories, the Lancaster Production Group was set up in September 1941. The group originally consisted of three members, A. V. Roe in Newton Heath and the new factory at Chadderton, Metropolitan Vickers at Trafford Park and Sir W. G. Armstrong Whitworth and Co. in Coventry. The group was later joined by Vickers-Armstrong at Castle Bromwich. Increased demand for Lancasters resulted in expansion of the group to include Vickers at Chester and the Austin Motor Company (Austin Aero) in Birmingham.

The first production Lancaster, L7527, commenced production as a Manchester I airframe but was modified on the production line to Lancaster Mark I standard. L7527 made its maiden flight from Woodford Aerodrome on 31 October 1941, and several suggestions for modifications were made. The most significant change was the removal of the Nash and Thompson FN64 ventral turret, which was conceived to be of little use, especially in night operations. The aircraft was declared fit for service with Bomber Command by A&AEE at Boscombe Down. It had been decided to re-equip one of the squadrons operating the obsolete Hampden first as part of the phasing out of that aircraft rather than a squadron already using Manchesters. The first three airframes were delivered to No. 44 (Rhodesia) Squadron at Waddington on 24 December 1941, with four more received four days later to begin the replacement of its Hampdens. The decision meant that the Lancaster would serve for a short time alongside its less illustrious forebear. The Royal Air Force now had its new capable bomber.

In order to equip Bomber Command with the new aircraft, new production orders for Lancasters were awarded to the Lancaster Production Group. Contract B.69274/40 was awarded to A. V. Roe at Newton Heath for a total of 650 Lancaster Mark I aircraft. The figure was later revised to 407 aircraft, to be delivered in two batches. The first batch of 200 was to be delivered between February and July 1942, the second batch of 207 between July and November 1942. Contract B.69275/40 was awarded to Metropolitan Vickers for 170 Mark I and 30 Mark III aircraft to be delivered between September 1942 and May 1943.

## TECHNICAL SPECIFICATIONS

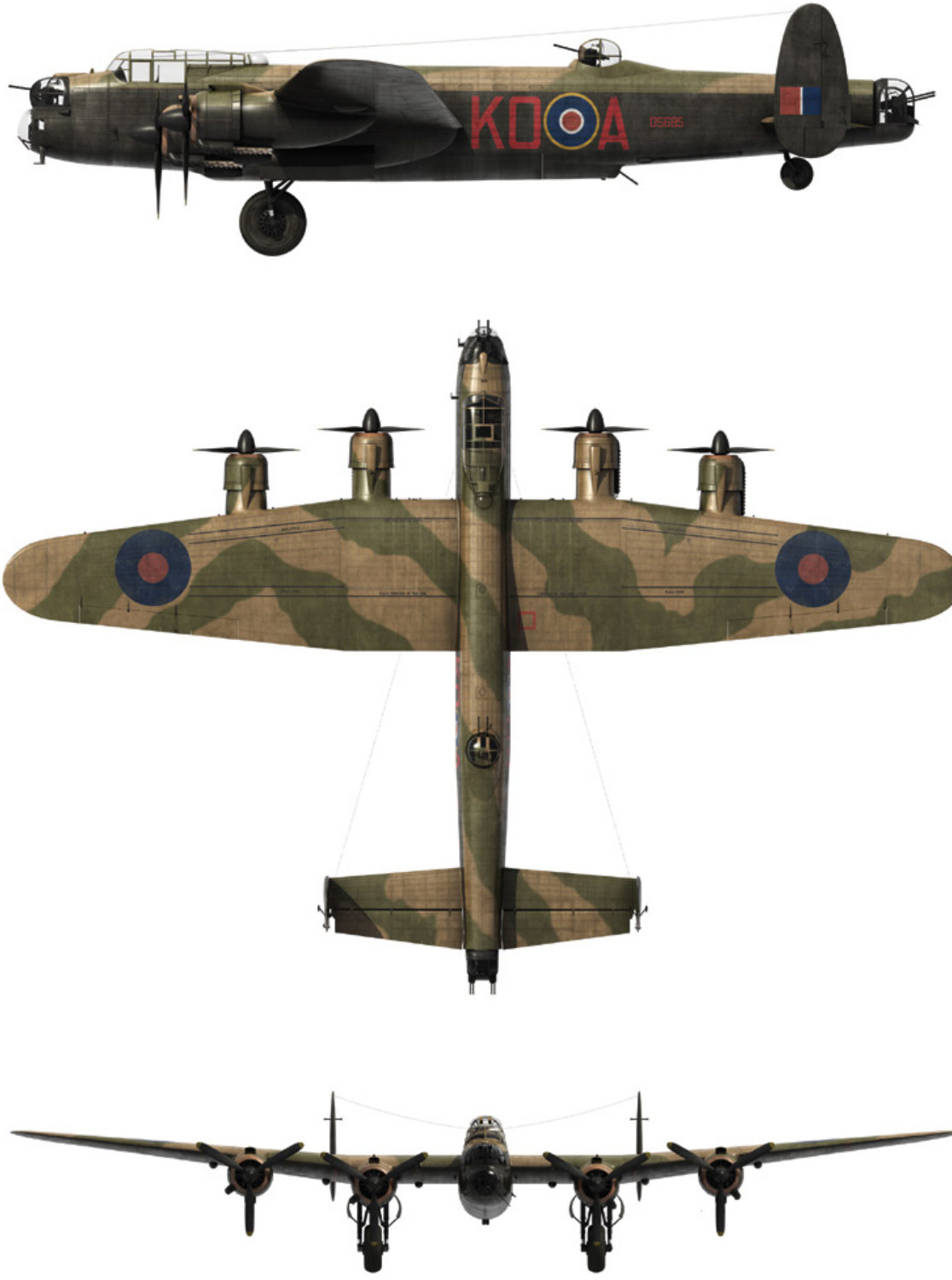
The Lancaster was designed from the start to be flown by a crew of seven, which initially included a second pilot. The role of second pilot was removed early in the type's gestation when a shortage of pilots available to the Royal Air Force made the provision of a second pilot a luxury that the force could not afford. Instead, one of the other crew members was given training as the pilot's assistant. Increased specialization of navigation and bomb aiming resulted in the two tasks being split into two separate crew roles, provision for which had always been included in the design of the Lancaster. Another role designed into the crew of the Lancaster was that of specialist flight engineer, which had resulted from the complexity of the modern four-engine bombers

B

**LANCASTER B. MARK II**

Lancaster B. Mark II, DS685 of 115 Squadron, 2 August 1943. DS685 is equipped with the standard engine cowling fitted to all but the first few production machines. DS685 is fitted with bulged bomb bay doors and the FN.64 ventral turret.

© Osprey Publishing • www.ospreypublishing.com




© Osprey Publishing • www.ospreypublishing.com

Avro Lancaster B. Mark I, HK564 (JN-F) of No. 75 Squadron. The general layout of the Lancaster is shown well in this image. The aircraft is fitted with the bulged bomb bay doors fitted to later production Mark Is. The mid-upper turret is fitted with the fairing to prevent the gunner shooting at his own aircraft accidently. The position of the ailerons is shown clearly by the gaps in the trailing edge of the wing. The aircraft lost both ailerons during a raid on 25 August 1944 and still brought its crew home.

received by Bomber Command. The standard crew of a Lancaster was made up of the pilot, who also commanded the aircraft, navigator, flight engineer, bomb aimer (who also doubled up as front gunner when not engaged in his bomb-aiming role), wireless operator, mid-upper gunner and tail gunner.

The Lancaster airframe was of all-metal construction, 69ft in length with a wingspan of 102ft, and 20ft in height. The fuselage was constructed of light alloy monocoque, which accommodated the crew and their equipment, the bomb bay and defensive armament. The fuselage, roughly oval in cross section, was broken down for production into five modular sections: the nose section, front fuselage, intermediate section, rear-centre, and the rear fuselage. Each section was fully assembled and equipped before being brought together.

The nose section consisted of the fuselage section, which was fitted with a hemispherical transparent Perspex dome that incorporated a flat circular glass vision panel for bomb aiming (although this was not fitted on all aircraft). The floor of the section was fitted with the forward escape hatch, and the walls with numerous windows for the bomb aimer. The forward power-operated Nash and Thompson FN5 turret was fitted above and behind the bomb aimer's blister.

The front fuselage section contained the main cockpit area, in which was sited the pilot's position on a raised platform on the forward port side of the cabin. The rest of the cabin in the front fuselage accommodated the navigator, wireless operator and flight engineer with their equipment. Below the floor of the cabin could be found the forward part of the bomb bay. The nose and front fuselage sections when connected together were just over 20ft in length and for transportation the two sections would remain joined.

The intermediate centre section was 8ft in length and was constructed around the front and rear main spars for the wing. The centre section also contained the emergency escape hatch in the roof for escape should the aircraft be forced to ditch on water. The bomb bay continued under the cabin floor on the centre section.

The rear-centre section was over 20ft in length, and extended from the trailing edge of the wing to the tail. The section was fitted with a Nash and Thompson power-operated FN50 dorsal turret and, on early aircraft, a Nash



© Osprey Publishing • www.ospreypublishing.com

and Thompson FN64 ventral turret in the bottom of the section aft of the rear of the bomb bay. A small emergency escape hatch was located in the roof of the rear-centre section. Underneath the floor of the cabin, which consisted of a walkway to the rear of the aircraft, lay the rear of the bomb bay, which extended for a total length of 33ft across the front fuselage, intermediate and rear-centre sections.

The rear fuselage section was 21ft in length and built around the tail plane spars, which passed through the rear of the section underneath which was located the tail wheel assembly. The rear section contained the main crew entrance and exit doorway, situated on the starboard side of the fuselage, and a Nash and Thompson power-operated FN20 turret at the extreme rear of the section. The tail unit was fitted to the rear section and consisted of a tail plane of 33ft span with large 12ft high fins and rudders at the ends of the tail plane, which including elevators measuring 237sq. ft.

The Lancaster's wings were of dihedral cantilever structure, built around the front and rear main spars in the centre section of the fuselage. The wings were divided for construction and transportation into five sub-assemblies: the centre section, two outer wing sections (port and starboard) and two wing tip sections (port and starboard).

The wing centre section had a span of 25ft and was integral with the fuselage centre section. The inboard engine nacelle was located on the wing centre section and also housed the main undercarriage, which retracted backwards into the extended rear of the engine nacelle.

The outer wing section and wing tip sections had a span of 74ft with the outer engine nacelle fitted to the outer wing section. The ailerons were mounted in the trailing edge of the outer wing section.

The wings were fitted with hydraulically operated split flaps, and initially four fuel tanks within the wing structure, which later increased to six tanks. When assembled the wings had a total area of 1,300sq. ft.

The undercarriage fitted to the inner engine nacelles consisted of a retractable Dowty oleo-pneumatic system equipped with a single wheel and tyre. The undercarriage lever in the cockpit was locked down by a safety bolt to prevent accidental retraction on the ground, which had to be moved aside to raise the undercarriage in flight. Undercarriage indicators in the cockpit showed two green lights when the undercarriage was locked down and two red lights when it was locked up. The Lancaster Mark X differed in having a pictorial undercarriage fitted. A warning horn sounded if either inboard throttle was closed when the undercarriage was not locked down. The tail wheel was a non-retracting Dowty oleo-pneumatic assembly.

The Lancaster was fitted with a dazzling variety of electronic equipment during its service life, which will be covered later in this volume.

## THE LANCASTER: MARK BY MARK

Identifying marks of the Lancaster can at best be described as tricky due to the variety of equipment fitted to various aircraft over time. For example, not all Mark I Lancasters were fitted with H2S radar with its obvious blister, and other differences, such as those between Mark I and Mark III, are almost impossible to discern without reference to serial numbers. Even then this is not conclusive, as will be discussed in the analysis of the main salient differences between marks of the Lancaster that follows.



© Osprey Publishing • www.ospreypublishing.com

## Lancaster B. Mark I

| | |
|---|---|
| **Power:** | 4 1,280hp Rolls-Royce Merlin XX engines with 3-bladed De-Havilland D.H.5/40 variable pitch airscrews, interchangeable with Hamilton A 5/138 airscrews |
| **Dimensions:** | Span: 102ft |
| | Length: 59ft 6in |
| | Height: 20ft |
| | Wing area: 1,300sq ft |
| **Weight:** | Empty: 37,000lb |
| | Normal take-off weight: 65,000lb |
| **Performance:** | Max speed: 275mph at 15,000ft |
| | Service ceiling: 24,500ft |
| | Range: 2,530 miles (7,000lb load) or 1,700 miles (12,000lb load) |
| **Armament:** | Early aircraft: 9 Browning .303 machine guns in power-operated turrets: 2 in FN5 nose, 2 in FN50 mid-upper, 1 in FN64 ventral and 4 in FN20 tail turrets |
| | Later aircraft: 8 Browning .303 machine guns in power-operated turrets: 2 in FN5 nose, 2 in FN50 mid-upper, and 4 in FN20 tail turrets |
| | 8,000lb of bombs or 12,000lb with bulged bomb doors |
| **Serials:** | A. V. Roe: L7527-L7549, L7565-L7584, R5482-R5517,R5537-R5576, R5603-R5640, R5658-R5703, R5274-R5763, W4102-W4140, W4154-W4201, W4230-W4279,W4301-W4340, W4355-W4384, ED303-ED334, ED347-ED386, ED389, ED391-ED392, ED394, ED409, ED411-ED412, ED414, ED418, ED420, ED422, ED425, ED430, ED436, ED439, ED443, ED446-ED447, ED451, ED498, ED521-ED522. ED525, ED528, ED533, ED537, ED548, ED550, ED552, ED554, ED567, ED569, ED586, ED591, ED594, ED600-ED601, ED604, ED610, ED622,ED631, ED661, ED692, ED703, ED715, ED732, ED735, ED749, ED751, ED754-ED755, ED757-ED758, ED761-ED763, ED766, ED769-ED770, ED773-ED774, ED777-ED778, ED780-ED782, PB643-PB647, PB671-PB674, PB686-PB692, PB695-PB696, PB703-PB705, PB708, PB721-PB727, PB730-PB732, PB734-PB757, PB759-PB768, PB780-PB823, PB836-PB881, PB893-PB922, PB924-PB936, PB949-PB959, PB961, PB981-PB994, LM301-LM310, ME328, ME330, ME350, ME352, ME371-ME374, ME383-ME384, ME419-ME421, ME431-ME440, ME445-ME451, ME455-ME458, ME470, ME475-ME477, ME479-ME480, ME482, ME490, ME495 |
| | Metropolitan Vickers: R5842-5868, R5888-R5917, W4761-W4800, W4815-W4864, W4879-W4905, W4918-W4967, W4980-4982, DV277-DV282, DV291-DV297, DV299-DV312, DV324-DV345, DV359-DV407, ME554-ME596, ME613-ME650, ME663-ME704, ME717-ME759, ME773-ME814,ME827-ME868, PD198-PD239, PD252-PD296, PD309-PD349, PD361-PD404, PD417-PD444, RA500-RA547, RA560-RA607, RA623-RA627, RA787-RA806, SW243-SW279, TW915-TW929 |
| | Sir W. G. Armstrong Whitworth and Co.: LL740-LL758, LL771-LL813, LL826-LL867, LL880-LL923, LL935-LL977, LM100-LM142, LM156-LM192, LM205-LM243, LM257-LM296, NF906-NF939, NF952-NF999, NG113-NG149, NG162-NG206, NG218-NG259, NG263-NG308, NG321-NG367, NG379-NG421, NG434-NG469, NG482-NG503, RF120-RF161, RF175-RF197, SW296-SW316, TW858-TW873, TW878-TW911 |
| | Vickers-Armstrong: HK535-HK579, HK593-HK638, HK644-HK664, HK679-HK710, HK728-HK773, HK787-HK806, PP663-PP695, PP713-PP758, PP772-PP792, PA158-PA198, PA214-PA239, PA252-PA288, PA303-PA351, PA365-PA396, PA410-PA452, PA473-PA478, PA509 |
| | Austin Motors: NN694-NN726, NN739-NN786, NN798-NN816, NX548-NX589, NX603-NX610 |
| **Production:** | A. V. Roe: 2,780 |
| | Metropolitan Vickers: 893 |
| | Sir W. G. Armstrong Whitworth and Co.: 886 |
| | Vickers-Armstrong: 535 |
| | Austin Motors: 150 |
| | **Total Mark I Production: 5,244** |

The first squadron to receive the Lancaster Mark I was No. 44 (Rhodesia) Squadron of No. 5 Group at RAF Waddington. As with all new aircraft, the Lancaster was not without teething troubles; a diving test led to the crash of R5539, which was found to have been caused by tail plane surface failure. The aircraft was found to have other minor issues that necessitated strengthening the wing tips to prevent them from fracturing, and a modification to the fuel system to prevent airlocks causing fuel pump blockages. The basic durability of the design meant these teething troubles did not affect operational availability, unlike the Manchester, and few modifications were made due to technical reasons; most were made for operational reasons.

The ventral turret was quickly deleted from production airframes due to the perception that it was of little use. The turret was also hampered by poor



© Osprey Publishing • www.ospreypublishing.com

visibility and the lack of a dedicated crew member to operate it. The Mark I therefore saw service both with and without the ventral turret. The mid-upper turret on early production aircraft was un-faired, but this left the gunner with unrestricted depression of his weapons, which resulted in a danger of him accidentally firing on his own aircraft. In late 1942 a contoured fairing was added around the turret. It incorporated a track in which wheeled stalks ran that were connected to the guns to ensure that the weapons could not train on any part of the aircraft. Thus Mark I airframes can be seen with a mixture of faired and un-faired turrets during their service lives.

The fuselage retained the rows of small rectangular windows inherited from the Manchester, but these were often painted over, giving the impression that they did not exist. The forward pair of windows in the fuselage side was deleted from JB/LM production series onward.

Some production aircraft were fitted with an enlarged bomb aimer's blister, which featured a shallower angled, optically flat aiming panel. In addition, during 1942, specially designed bulged bomb bay doors appeared on selected aircraft to accommodate the new 8,000lb bomb. The original turrets on Mark I aircraft were badly affected by rain and dirt, and so a sliding panel was fitted to some tail turrets. Later, the entire central Perspex panel was removed on some aircraft, giving much improved visibility for only marginal temperature drop for the gunner in an already cold environment.

Early aircraft had their leading edges smeared with de-icing paste, while later airframes were fitted with thermal de-icing equipment as standard.

Regardless of these 'modifications', all the aircraft equipped with these various combinations of equipment and fittings are classified as Lancaster Mark I.

## Lancaster B. Mark II

| | |
|---|---|
| **Power:** | 4 1,735hp Bristol Hercules XVI engines with Rotol airscrews rotating counter clockwise (unlike the Merlin) |
| | Aircraft with serials DS601-DS627 were fitted with 4 1,735hp Bristol Hercules VI engines |
| **Dimensions:** | As per B. Mark I |
| **Weight:** | Empty: 37,000lb |
| | Normal take-off weight: 63,000lb |
| **Performance:** | Max speed: 265mph at 14,000ft |
| | Service ceiling: 18,500ft |
| | Range: 2,370 miles at 15,000ft |
| **Armament:** | 10 Browning .303 machine guns in power-operated turrets: 2 in FN5A nose, 2 in FN50 dorsal, 2 in FN64 ventral and 4 in either FN20 or FN120 rear turrets. (Some later aircraft were fitted with a single .50 Browning machine gun in the fuselage floor in place of the FN64 turret in early 1944) |
| | Up to 14,000lb of bombs or with bulged and extended bomb bay doors on some aircraft a single 8,000lb bomb could be carried |
| **Serials:** | DT810, DS601-DS635, DS647-DS692, DS704-DS741, DS757-DS797, DS813-DS852, LL617-LL653, LL666-LL704, LL716-LL739 |
| **Production:** | Sir W. G. Armstrong Whitworth and Co.: 300 |

The Lancaster Mark II is probably the easiest of all the marks to identify by its four Bristol Hercules radial engines, which change the look of the aircraft considerably. The Mark II was a result of concerns that the demand placed upon Rolls-Royce for the Merlin engine could produce a bottleneck in production of airframes. The Merlin engine was the RAF's most common power plant used to power the Spitfire, Hurricane, Whitley, Wellington, Battle, Beaufighter and other types. The Air Ministry and the RAF were also concerned



© Osprey Publishing • www.ospreypublishing.com

Lancaster B. Mark II of No. 460 Squadron RAAF, 3 May 1944. This aircraft landed at an Eighth Air Force base and is being inspected by American personnel. The Mark II was fitted with Bristol Hercules engines, the port inner of which is visible. The mission tally painted on the nose of the aircraft indicates that it has completed 12 missions.

about the vulnerability that came with having all their power eggs in one basket, should the Luftwaffe be able to disrupt Merlin production. This fear, despite ongoing discussions for American production of Merlin engines, resulted in the need to find alternative power plants for the Lancaster. The concept of the four-engine Manchester had barely been proven when the Air Ministry officially acknowledged the need for an alternative option and the Hercules engine was selected.

The Air Ministry placed an order for a pair of prototypes (DT810 and DT812) and a healthy production order for the Lancaster B. Mark II almost immediately. Only DT810 would be built as a prototype and sent to A&AEE at Boscombe Down for tests before series production began. The prototype was ordered with the production order because both A. V. Roe and Metropolitan Vickers were heavily engaged with Lancaster B. Mark I production and neither would be able to accept a contract for construction of the Mark II. A. V. Roe's experimental department was able to produce the prototype in very short order as a supply of components was readily available at the Chadderton plant, which would allow the engineers in the experimental department to hand build DT810 and overcome any issues with fitting the Bristol Hercules engines to a wing designed for the Merlin.

Production of the Mark II would be contracted to Sir W. G. Armstrong Whitworth and Co. at their works in Newton Road, Nuneaton. Production of the Lancaster Mark II could not begin immediately as Armstrong Whitworth was still heavily engaged with the Whitley, production of which was unexpectedly extended in 1941 when orders were received from RAF Coastal Command for the airborne search radar equipped Whitley Mark VII. As a result of the extension to Whitley production, the order for the Lancaster Mark II was delayed until May 1941. The Ministry of Aircraft Production finally gave the order for production of the Whitley to cease in March 1942 so that Lancaster Mark II production could begin under order 239/SAS/C4(C) for 200 aircraft, which required the aircraft to be delivered between September 1942 and October 1943. The order was later extended to include another 100 to be delivered between October 1943 and March 1944. It took



© Osprey Publishing • www.ospreypublishing.com

a full 12 months for production to switch from Whitley to Lancaster, but Armstrong Whitworth began systematically replacing production jigs and tools as the last Whitleys moved down the production line.

The first Mark II aircraft, DS601 and DS602, were delivered to Boscombe Down for service trials. The aircraft was found to be faultless, although the Bristol Hercules engines were found to be more powerful than early Merlin engines, which offset the increased drag caused by the radial engines over the sleeker inline Merlins, but required more careful engine management and used more fuel until the later Mark IIs were fitted with the improved Hercules XVI engines. The first Lancaster Mark II unit was No. 61 Squadron at RAF Syerston.

The standard engine fitted to the Mark II was the Bristol Hercules XVI, which changed the lines of the aircraft considerably, although the first few production aircraft were fitted with the Bristol Hercules VI. Both engines were rated at 1,735hp and are virtually indistinguishable. The only way to identify aircraft fitted with the different engines is by serial number, DS601 to DS627 being fitted with the Hercules VI engine.

The Mark II was initially identical to the Mark I other than its engine fit; however, the Mark II was fitted with extended bomb doors early in the production run as standard in order to accommodate the 8,000lb bomb. The FN64 ventral turret was also re-introduced following Bomber Command's experience with German night fighters equipped with upward firing Schrage Musik cannon. The turret is clearly seen immediately aft of the bomb doors on aircraft fitted with extra armament. The defensive armament of the Mark II was changed at the rear of the aircraft, where the FN20 turret was generally replaced by a Nash and Thompson FN120 turret that was of lighter construction and equipped with improved gun sights. The Mark II was also fitted with the shallow nose blister.

Avro Lancaster Mark II bomb bay. The Lancaster inherited its bomb bay from the Manchester. The size of the bomb bay was a throwback to the requirement built into the Manchester to allow it to carry two torpedoes. The large drum-like bomb is a 4,000lb 'cookie' bomb, either side of which are SBC incendiary containers. Forward is a mix of 1,000lb and 250lb bombs.

The aircraft was also refined with the fitting of bell-shaped spinner covers to the engines and Beaufighter pattern air intakes, which can be identified from the early production machine by the shorter intake feed pipe that begins just forward of the cooling gills on the cowling, as opposed to the early fit that extends to just aft of the cowling ring. The exhausts were also changed on later production Mark IIs, which were equipped with flame-damping exhausts.

Fears that production of Rolls-Royce Merlin engines would be insufficient to meet demand and that the entry of the United States into the war would result in them concentrating on their own urgent re-armament requirements, thus reducing production of Packard-built Merlin engines, never materialized. The decision was taken to give priority for Bristol Hercules engines to the Handley Page Halifax Mark III, and so no further orders were placed for the Lancaster Mark II. As a result, only 300 Lancaster B. Mark IIs were completed



© Osprey Publishing • www.ospreypublishing.com

before Armstrong Whitworth switched over to Merlin-powered Lancaster B. Mark I/III production.

## Lancaster B. Mark III

| | |
|---|---|
| **Power:** | 4 1,420hp Packard Merlin 28 engines |
| **Dimensions:** | As per B. Mark I |
| **Weights:** | As per B. Mark I |
| **Performance:** | As per B. Mark I |
| **Armament:** | 8 Browning .303 machine guns in power-operated turrets: 2 in FN50 nose, 2 in FN50 mid-upper and 4 in FN20 tail turrets<br>12,000lb bomb load |
| **Serials:** | A. V. Roe: ED362, ED371, ED378, ED383, ED387-ED388, ED390, D393, ED395-ED396, ED408, ED410, ED413, ED415-ED417, ED419, ED421, ED423-ED424, ED426-ED429, ED431-ED435, ED437-ED438, ED440-ED442, ED444-ED445, ED448-ED450, ED452-ED453, ED467-ED497, ED499-ED504, ED520, ED523-ED524, ED526-ED527, ED529-ED532, ED534-ED536, ED538-ED547, ED549, ED551, ED553, ED555-ED566, ED568, ED583-ED585, ED587-ED590, ED592-ED593, ED595-ED599, ED602-ED603, ED605-ED609, ED611-ED621, ED623-ED630, ED645-ED660, ED662-ED668, ED688-ED691, ED693-ED702, ED704-ED714, ED716-ED731, ED733-ED734, ED736-ED737, ED750, ED752-ED753, ED756, ED759-ED760, ED764-ED765, ED767-ED768, ED771-ED772, ED775-ED776, ED779, ED783-ED786, ED799-ED842, ED856-ED888, ED904-ED953, ED967-ED999, EE105-EE150, EE166-EE202, JA672-JA718, JA843-JA876, JA892-JA941, JA957-JA981, JB113-JB155,JB174-JB191, JB216-JB243, JB215-JB320, JB344-JB376, JB398-JB424, JB453-JB488, JB526-JB567, JB592-JB614, JB637-JB684, JB699-JB748, ND324-ND368, ND380-ND425, ND438-ND479, ND492-ND538, ND551-ND597, ND613-ND658, ND671-ND715, ND727-ND768, ND781-ND826, ND839-ND882, ND895-ND936, ND948-ND996, NE112-NE151, NE163-NE181,PA694-PA999, PB112-PB152, PB171-PB213, PB226-PB267, PB280-PB308, PB341-PB385, PB397-PB438, PB450-PB490, PB504-PB542, PB554-PB596, PB609-PB642, PB648-PB653, PB666-PB670, PB675-PB685, PB693-PB694, PB697-PB702, PB706-PB707, PB728-PB729, PB733, PB758, PB923, PB960, PB962-PB980, LM311-LM346, LM359-LM395, LM417-LM448, LM450-LM493, LM508-LM552, LM569-LM599, LM615-LM658, LM671-LM697, LM713-LM756, RE115-RE140, RE153-RE188, RE200-RE222, RE225-RE226, SW319-SW345, SW358-SW377, TW263-TW273, ME295-ME327, ME329, ME331-ME337, ME351, ME353-ME370, ME375-ME382, ME385-ME395, ME417-ME418, ME422-ME430, ME441-ME444, ME452-ME454, ME471-ME474, ME478, ME481, ME483-ME489, ME491-ME494, ME496-ME503, ME517-ME551<br>Metropolitan Vickers: W4983-W5012, DV155-DV202, DV217-DV247, DV263-DV276, DV283-DV290, DV298<br>Sir W. G. Armstrong Whitworth and Co.: RF198-RF216, RF229-RF273, RF286-RF326, SW283-SW295 |
| **Production:** | A. V. Roe: 2,780<br>Metropolitan Vickers: 132<br>Sir W. G. Armstrong Whitworth and Co.: 118<br>**Total Mark III Production: 3,030** |

The possibility of a supply shortage of Rolls-Royce Merlin engines had already led the Ministry of Aircraft Production to order the Bristol Hercules-powered Lancaster B. Mark II and switch power plants on other aircraft, such as the Handley Page Halifax and Bristol Beaufighter, to Bristol Hercules engines. The same concerns about possible disruption and capacity issues at Rolls-Royce

C

**1: MID AND UPPER TURRETS**

The early mid-upper turret without fairing, and the later mid-upper turret with fairing.

**2: FN64 VENTRAL TURRET**

The ventral turret was fitted to early production Mark I Lancasters, but was deleted early on as it was felt to be of little use and did not have a dedicated crew member. It was reintroduced on the Mark II and some later production aircraft.

**3: H2S FAIRING**

The rear part of the blister was normally left unpainted.

**4: MANCHESTER AND LANCASTER TAIL ASSEMBLIES**

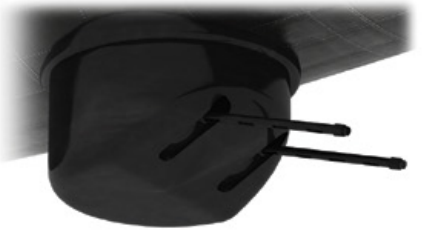
The Manchester tail unit consisted of a triple-finned assembly. The central fin was deleted on the Mark Ia, and the outer fins were enlarged. The Lancaster tail assembly consisted of large oval twin fins at the end of the tail plane.

**5: UPKEEP MINE MOUNTING**

The Type 464 'Provisioning' Lancaster was modified to carry a single Upkeep mine in its bomb bay. The bomb was slung in a special cradle that allowed the bomb to be spun backwards to give it the ability to skip over water surfaces.

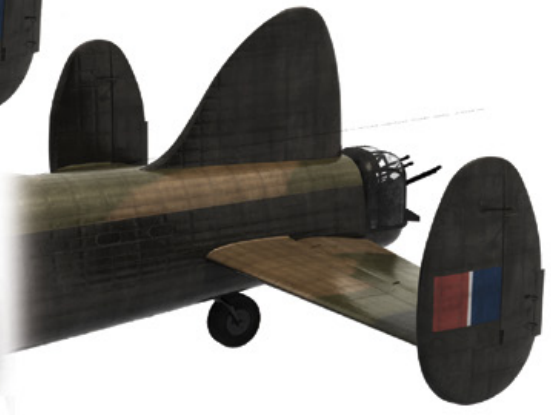
© Osprey Publishing • www.ospreypublishing.com

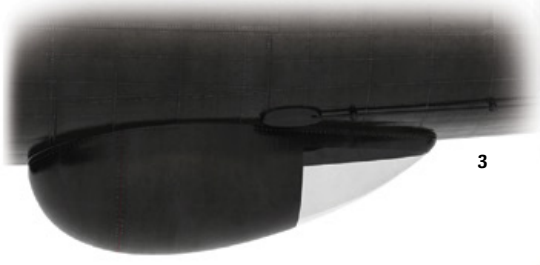
1



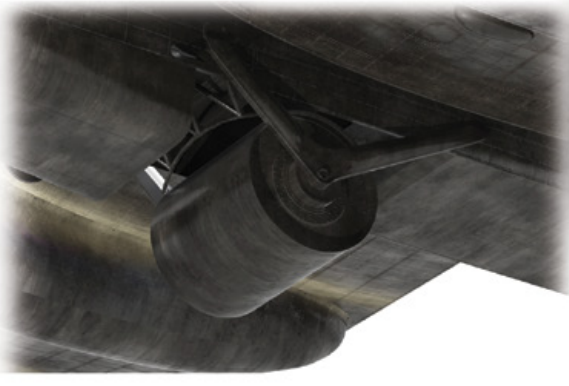
2

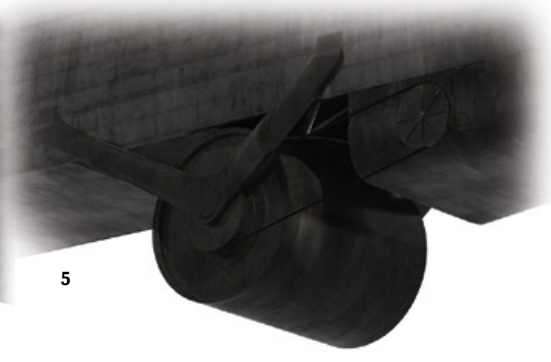
4





3





5

© Osprey Publishing • www.ospreypublishing.com

Lancaster B. Mark III RE172. This view of RE172 shows how difficult it is to distinguish between the Mark I and Mark III Lancaster, although it does give a clear picture of the standard Bomber Command camouflage pattern used up until the end of the war.

should the Luftwaffe intervene led to an agreement with the United States for Merlin production to be undertaken under licence by Packard. Production of Packard Merlins began relatively quickly since Rolls-Royce had been anticipating the need to source engines from the United States, where production was less likely to be disrupted. Production had been discussed with the Ford Motor Company for some time, and in fact full sets of engine drawings had been shipped to Ford before the fall of France in 1940.

The first prototype Lancaster B. Mark III, W4114, fitted with Packard Merlin 28 engines, was delivered to A&AEE for trials in October 1942. Contract B.69274/40 was awarded to A. V. Roe for a fourth production batch of 620 Lancaster Mark I/IIIs for delivery between November 1942 and June 1943. Contract B.69275/40 awarded to Metropolitan Vickers was amended to include a further 200 Mark Is and Mark IIIs for delivery between May and November 1943. A new contract (No. 1807) was also awarded to A. V. Roe, which would be the biggest contract for Lancaster production awarded. It specified that 900 Lancaster Mark I and Mark IIIs were to be constructed at Newton Heath for delivery commencing June 1943 after completion of existing Lancaster production contracts, and a further 350 were to be built at A. V. Roe's new plant at Yeadon for delivery commencing November 1942.

Lancaster production used both Rolls-Royce and Packard Merlins as quickly as they were available. When the American Packard Merlin was fitted to an aircraft on the production line, it was designated a Mark III. When Rolls-Royce Merlins were fitted, then the aircraft was a Mark I. The aircraft



© Osprey Publishing • www.ospreypublishing.com

are impossible to distinguish, being completely identical other than the engines the aircraft had fitted in their nacelles, and so the only way to tell them apart is by serial number, although this will only indicate what mark the aircraft was built as, and not what it may have changed to during service.

The Rolls-Royce- and Packard-built Merlins were completely interchangeable, and as aircraft completed sorties and added hours to the engines' working life, faults would of course begin to develop. It was found that there was no design flaw in the engine, the faults being linked to simple operational wear and tear. Aircraft with engine faults would often have engine changes, as would aircraft that had simply reached a number of hours' flying time that necessitated an engine change under the RAF's maintenance regimes. Since the Packard and Rolls-Royce engines were interchangeable, the maintenance units would replace an aircraft's power plants with engines that were available from batches delivered or reconditioned. This meant that a Lancaster Mark I could be fitted with replacement Packard engines, becoming an instant Mark III, or vice versa. It was not uncommon for an aircraft to have a mixture of Packard- and Rolls-Royce-built engines, as faulty or battle-damaged engines were replaced by maintenance units or on squadron. It is therefore best to view the two marks as a Lancaster Mark I/III, as it is impossible to determine what aircraft you are looking at without detailed reference to the maintenance records of the aircraft in question for the date of a photograph or reference.

The Packard Merlin had one difference from the Rolls-Royce-built engine, namely a tendency to overheat on take-off or landing, which whilst not a particular problem for an experienced pilot to manage could be fatal for a new pilot unfamiliar with the Lancaster. As a result, operational conversion units used only Rolls-Royce engines and Mark I aircraft.

## Type 464 'Provisioning' Lancaster

| | |
|---|---|
| **Power:** | As per B. Mark I |
| **Dimensions:** | As per B. Mark I |
| **Weight:** | Empty: 38,000lb<br>Normal take-off weight: 66,000lb |
| **Performance:** | As per B. Mark I |
| **Armament:** | 6 Browning .303 machine guns in power-operated turrets: 2 in FN5 nose and 4 in FN20 tail turrets<br>1 9,250lb 'Upkeep' mine |
| **Serials:** | A. V. Roe: Prototypes; ED765/G , ED817/G and ED825/G<br>Production; ED864/G, ED865/G, ED886G, ED887/G, ED906/G, ED909/G, ED910/G, ED912/G, ED915/G, ED918/G, ED921/G, ED923/G, ED924/G, ED925/G, ED927/G, ED929/G, ED932/G, ED934/G, ED936/G, ED937/G |
| **Production:** | A. V. Roe: 23 |

The Type 464 'Provisioning' Lancaster was a modification of the B. Mark I/III airframe to carry Barnes Wallis's 'Upkeep' mine, otherwise known as the 'bouncing bomb'. The development of the weapon and the Dams Raid operation will be covered in more depth later; this section will concentrate on the modifications made to the airframe.

The airframe of the Mark I/III Lancaster required a number of modifications in order to carry the Upkeep mine. The Upkeep mine required its own launch mechanism to induce the back spin required to make the bomb bounce over water. The mechanism was fitted into the bomb bay of the airframe and the bomb doors were removed. A small hydraulic motor was installed in the middle section of the cabin to drive the rotating mechanism in the bomb's



© Osprey Publishing • www.ospreypublishing.com

cradle, which imparted the necessary back spin. The increase in weight caused by the launch mechanism was offset by the removal of the dorsal turret.

To function correctly, the Upkeep mine required the aircraft to maintain a constant speed of 200mph at 60ft above the surface of the water in the target dams. The standard altimeter fitted to the Lancaster was viewed as too inaccurate at such a low level and was replaced by a more sensitive radio altimeter. It was also necessary to find a way to control a constant height of 60ft over the target, so the aircraft was fitted with two Aldis lamps mounted at the nose and rear of the bomb bay and synchronized to converge on the ground when the aircraft was precisely 60ft above. The standard bomb sight was replaced with a special bomb sight made from a triangle of wood with two wooden pegs at each corner of the base. When the pegs lined up with the towers on the dams, the aircraft would be at the correct distance from the dam wall and the bomb could be released.

Each of the Type 464 Lancasters was allocated a G suffix to their serial number. The G suffix indicated that the aircraft required special levels of security and was to be guarded at all times. After the Dams Raid, all the surviving aircraft were re-modified to standard Mark I/III configuration and were reissued to squadrons.

## Lancaster B. Mark X

| | |
|---|---|
| **Power:** | 4 Packard Merlin 38 (KB700 – KB 774)<br>4 Packard Merlin 228 |
| **Dimensions:** | As per B. Mark III |
| **Weight:** | As per B. Mark III except for a normal take-off weight of 61,500lb |
| **Performance:** | As per B. Mark III |
| **Armament:** | 10 .303 Browning machine guns in power-operated turrets: 2 in FN5, 2 in FN50 mid-upper, 2 in FN64 ventral and 4 in FN20 tail turrets. Later aircraft had the FN50 mid-upper turret replaced by Martin mid-upper turrets fitted with 2 .50 Browning machine guns<br>12,000lb of bombs |
| **Serials:** | KB700 – KB799, FM100 – FM229 |
| **Production:** | Victory Aircraft: 430 |

By 1942, Canada was already providing a major contribution to the Allied war effort in the air by providing air crew training facilities away from the

D

**1: AVRO LANCASTER B. MARK I (NO. 101 SQUADRON)**

PA238 (SR-Z) is equipped with Airborne Cigar (ABC) radio countermeasures. No. 101 Squadron's Lancasters were all equipped with ABC, the three long aerials on the aircraft showing it is fitted. PA238 is fitted with a Rose rear turret armed with two .50 Browning machine guns.

**2: AVRO LANCASTER SECOND PROTOTYPE**

DG595 was the second Lancaster prototype. It was near to production standard and was sent to Boscombe Down in August 1941 for flight testing. The ventral FN64 turret was fitted to DG595, but was deleted from production Lancasters early on.

**3: AVRO LANCASTER B. MARK I (FE) (NO. 35 SQUADRON)**

TW878 (TL-H) was one of No. 35 Squadron's Lancasters that took part in a goodwill tour of the United States of America in 1946 at the invitation of the USAAF. Sixteen Lancasters from the squadron toured the United States for most of August 1946, arriving back in the UK on 29 August.

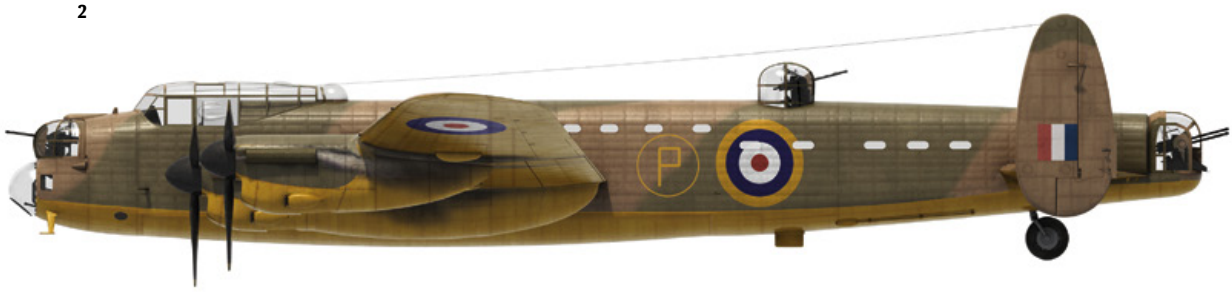
**4: AVRO YORK, THIRD PROTOTYPE (NO. 24 [COMMONWEALTH] SQUADRON)**

LV633 was the third prototype York. It was allocated to Sir Winston Churchill as his flying conference room. The aircraft carries the name 'Ascalon' under the cockpit.

© Osprey Publishing • www.ospreypublishing.com

1

2




3

4

© Osprey Publishing • www.ospreypublishing.com

Lancaster B. Mark I Special with Grand Slam bomb. The nose of the aircraft shows the fairing that replaced the nose turret.

predations of the Luftwaffe, and a steady stream of trained air crew. The Canadian government wished to contribute further by producing aircraft. An agreement was reached that resulted in the formation of the Victory Aircraft Corporation to produce Avro Lancasters under licence from A. V. Roe. The Corporation was wholly owned by the Canadian government. The Lancasters built in Canada were classified as the Lancaster B. Mark X.

The first 75 aircraft were fitted with Packard Merlin 38 engines, with the remaining aircraft fitted with the Packard Merlin 228 engine. The Mark X was outwardly identical to the B. Mark III except for the fitting of enlarged bomb bay doors as standard and the return of the FN64 ventral turret. The original needle-bladed propellers were superseded by broader paddle-bladed propellers from KB774 onwards, which gave improved rate of climb and altitude performance.

The majority of aircraft produced by Victory were flown or shipped across the Atlantic Ocean to Britain, where they were issued to Royal Canadian Air Force bomber squadrons operating from England.

## Lancaster B. Mark I Special

| | |
|---|---|
| **Power:** | 4 Rolls-Royce Merlin 24 engines |
| **Dimensions:** | Span: 102ft |
| | Length: 59ft 6in |
| | Height: 20ft |
| | Wing area: 1,300sq ft |
| **Weight:** | Loaded weight: 73,000lb |
| **Performance:** | Service ceiling: 17,000ft with weapon |
| | Max speed: 275mph at 15,000ft |
| | Range: 1,650 miles with Grand Slam bomb |
| **Armament:** | 4 Browning .303 machine guns in a power-operated tail turret. |
| | 1 22,400lb Grand Slam bomb |
| **Serials:** | PB995-PB998, PD112-PD139 |
| **Production:** | A. V. Roe: 32 |



© Osprey Publishing • www.ospreypublishing.com

Flying Officer E. W. Weaver of No. 617 Squadron with Grand Slam bomb loaded into a Lancaster B. Mark I Special's bomb bay. The bomb is held in place by two straps, one just behind Weaver's hand and one further aft (the pale band on the bomb).

The Mark I Special came about because of the need to find machines capable of carrying another of Barnes Wallis's wonder weapons, the 22,400lb Grand Slam bomb. The bomb was the biggest weapon dropped by the Royal Air Force during World War II. It measured a massive 25ft 5in long and was filled with 11,000lb of Torpex high explosive. The bomb was designed to penetrate especially tough targets such as the reinforced concrete U-boat pens built by Germany, which had reinforced concrete roofs up to 35ft thick and were impervious to any other weapon. The bomb was a free-fall weapon that reached supersonic speeds on its journey towards the ground while having spin imparted by its four canted tail fins, finally embedding itself deep in the target before exploding.

The massive proportions of Wallis's earthquake bomb meant that the only aircraft capable of carrying it was the Lancaster, albeit with a large amount of modification. The challenge of loading the Grand Slam bomb into the Lancaster resulted in the removal of the bomb bay doors and the modification of the bomb bay, including the fairing in of both ends, to fit a single weapon. The prototype B. Mark I Special flew with all three turrets in place, but it was soon realized that the nose and mid-upper turrets would need to be removed and faired in, in order to save weight. This left the aircraft equipped with just the four-gun tail turret, although later the tail turret would be reduced to mount just a pair of .50 Browning machine guns. The increased weight of the aircraft and bomb also led to the undercarriage being strengthened.

The fuel load of the Mark I Special was reduced to 1,675 gallons, restricting the aircraft to a range of 1,650 miles. This reduction in range did not affect the type's operational usefulness, as by the time it entered service in March 1945 the Allies were firmly ensconced in mainland Europe and the aircraft could reach all of the targets allocated to it from airfields in Europe.

The massive Grand Slam bomb challenged even the Lancaster, which even after modification and weight reductions was only capable of lifting the bomb to an altitude of 17,000ft. The ceiling of the Lancaster B. Mark I Special was lower than the level Barnes Wallis viewed as the ideal height from which the bomb should be released for maximum penetration. Despite his



© Osprey Publishing • www.ospreypublishing.com

fears, the practical results of using the new weapon proved the concerns to be unfounded, and 41 Grand Slam bombs were dropped from Lancasters before the end of the war.

## Lancaster B. Mark VI

| | |
|---|---|
| **Power:** | 4 uprated Rolls-Royce Merlin 85/87 engines |
| **Dimensions:** | As per B. Mark III |
| **Weight:** | As per B. Mark III |
| **Performance:** | As per B. Mark III |
| **Armament:** | As per B. Mark III |
| **Serials:** | DV170, DV199, JB675 |
| **Production:** | Metropolitan Vickers: 2<br>A. V. Roe: 1<br>A small number of conversions were also undertaken |

The Lancaster B. Mark VI was an attempt to fit the Lancaster with the uprated Rolls-Royce Merlin 85/87 engine. Two airframes (DV170 and DV199), built by Metropolitan Vickers at Trafford Park, were sent to Rolls-Royce to be fitted with the new engines in June and July 1943. A third airframe built by A. V. Roe at Newton Heath, JB675, was delivered to Rolls-Royce in November 1943 to become the first 'prototype' B. Mark VI. Following modification by Rolls-Royce, JB675 was delivered to A&AEE at Boscombe Down for trials. It later served with four different squadrons, although it only flew a single operational sortie, before being transferred to the Royal Aircraft Establishment (RAE) at Farnborough.

Only a small number of Lancasters were converted to B. Mark VI configuration, which served mainly with No. 7 Squadron at RAF Oakington and No. 635 Squadron at RAF Downham Market in the Pathfinder role.

The engines, whilst proving to be more powerful, gave cause for concern due to reliability issues, which is likely to have been the reason that the B. Mark VI had been withdrawn from operations by November 1944. The experience with the B. Mark VI was, however, useful, and influenced what would come later.

## Lancaster B. Mark I (FE)

| | |
|---|---|
| **Power:** | As per B. Mark I/III |
| **Dimensions:** | As per B. Mark I/III |
| **Weights:** | Varied depending upon tropical equipment fit |
| **Performance:** | Varied depending upon tropical equipment fit |
| **Armament:** | 6 Browning .303 machine guns in power-operated turrets: 2 in FN5 nose and 4 in FN20 tail turret |
| **Serials:** | Various aircraft were fitted as B. Mark I (FE) |
| **Production:** | 2 prototypes and various modified Mark I airframes |

The Lancaster B. Mark I (FE) was a result of the Royal Air Force beginning to give thought to operations in the Far East in 1944, in support of the United States Army Air Force's air offensive against Japan. It was decided to use the Lancaster for long-range strategic bombing operations in the Far East until the replacement was available. A number of completed Lancaster B. Mark I aircraft were taken from the production lines at Vickers-Armstrong and Sir W. G. Armstrong Whitworth and Co. for storage at No. 38 Maintenance Unit at Llanlow, awaiting tropicalization ready for despatch to the Far East to serve



© Osprey Publishing • www.ospreypublishing.com

This Lancaster B. Mark VI is fitted with an Armstrong Siddeley ASX jet engine in its bomb bay in late 1945 for flight tests. The nose turret has been faired in to save weight, since it is not required.

with 'Tiger Force', the RAF's task force created for service against Japan alongside the United States Army Air Force. These aircraft were designated Lancaster B. Mark I (FE).

In view of the long distances involved in operating in the Pacific Theatre of Operations, a number of suggestions were made concerning ways in which the Lancaster's range could be increased. One idea saw two Lancasters, HK541 and SW244, converted to carry large saddle tanks on the upper central fuselage. These long-range fuel tanks were fitted in a large fairing, which extended from the cockpit to just aft of the trailing edge of the wing and necessitated the removal of the mid-upper turret. The tanks increased fuel capacity by 1,500 gallons, but also increased the all-up weight of the aircraft to 72,000lb. HK541 underwent trials at A&AEE at Boscombe Down before being sent to Mauripor in India for in-theatre trials in May 1944, being followed by SW244 in August 1945. The two aircraft underwent trials with No. 1577 Flight, where it was found that the aircraft's handling characteristics were poor, and the project was abandoned. The aircraft were flown home and scrapped.

Another idea was for 600 Lancasters to be converted to in-flight refuelling tankers. In-flight refuelling had been demonstrated before the war, although its application in military operations was relatively untried. Trials began at A&AEE at Boscombe Down at the end of 1944 using LM730, which had been modified with in-flight refuelling couplings. Delays in the arrival of the Lincoln and the end of the war meant that the programme's relevance became academic and the project was cancelled.

Despite the trials with saddle fuel tanks and in-flight refuelling, it was decided that 'Tiger Force' would be equipped with tropicalized standard Lancaster B. Mark I, B. Mark III or B. Mark VII airframes. The mid-upper turrets would be removed to allow the FE aircraft to be fitted with an additional 400-gallon fuel tank in the bomb bay. The FE-designated aircraft



© Osprey Publishing • www.ospreypublishing.com

were also all to be fitted with the best navigation equipment available, including Gee, Loran, Rebecca and H2S.

The atomic bomb attacks on Hiroshima and Nagasaki brought an end to the war in the Pacific, and the need for 'Tiger Force' ended. The force disbanded in October 1945 and all of its Lancasters had their mid-upper turrets refitted, as they were no longer required to carry out long-range missions.

The end of the war brought about a considerable reorganization of the Royal Air Force, in particular Bomber Command, which was about to introduce the Lancaster B. Mark IV and B. Mark V into service. The post-war RAF decided to keep the B. Mark I (FE) for service in the Middle East and Far East, whilst 'standard' aircraft would serve with Bomber Command at home.

## Lancaster B. Mark VII (FE)

| | |
|---|---|
| **Power:** | As per B. Mark I |
| **Dimensions:** | As per B. Mark I |
| **Weight:** | As per B. Mark I except for an all-up weight of 72,000lb |
| **Performance:** | As per B. Mark I |
| **Armament:** | Early aircraft: 8 .303 Browning machine guns in power-operated turrets: 2 in FN5 nose, 2 in FN50 mid-upper and 4 in FN20 rear turrets<br>Main production run: 2 .303 Browning machine guns in power-operated FN5 nose turret and 4 Browning .50 machine guns; 2 in electrically operated Martin frameless mid-upper turret and 2 in Fraser Nash FN82 rear turret<br>12,000lb bomb load |
| **Serials:** | NN801, NX548-NX589, NX603, NX610, NX611-NX648, NX661-NX703, NX715-NX758, NX770-NX794, RT670-RT699 |
| **Production:** | Austin Motors: 230 |

The Lancaster B. Mark VII was intended from the outset for 'Tiger Force'. Austin Motors built the prototype B. Mark VII, NN801, which was the forerunner of 230 aircraft built by Austin Motors at Longbridge.

The B. Mark VII was externally similar to the B. Mark I. The main visible difference was the replacement of the FN50 mid-upper turret with a Martin frameless unit. The mid-upper turret on the B. Mark VII was moved forward to a position just aft of the trailing edge of the wing. The new position caused some difficulty with crew movement fore and aft, but increased the ease of access and escape for the mid-upper gunner. The supply of the American Martin turret was delayed and so the first four aircraft (NX548, NX589, NX603 and NX610) were fitted with the FN50 turret in the new position intended for the Martin unit and the FN20 tail turret. These aircraft were classified as Lancaster B. Mark VII (interim). The Martin unit became available for the main production run, at which time the tail turret was also replaced with the Nash and Thompson FN82 rear turret equipped with two Browning .50 machine guns.

All the B. Mark VII (FE) aircraft saw service overseas prior to the end of World War II, except for NX558, which was sent to A. V. Roe for trials.

Lancaster B. Mark VII (FE) NX678 of IX Squadron, Salbani, India in 1946. The Mark VII (FE) mainly saw service overseas with the RAF after the war.



© Osprey Publishing • www.ospreypublishing.com

## Lancaster A.S.R./G.R./MR. 3

| | |
|---|---|
| **Technical Details:** | All details as per Lancaster B. Mark III |
| **Armament:** | 6 Browning .303 machine guns in power-operated turrets: 2 in FN5 nose and 4 in FN20 tail turrets |

Lancaster A.S.R. 3 (later GR3) PB641 was originally built as a B. Mark III but was converted to A.S.R. 3 standard in 1945. The H2S blister (fitted to all ASR aircraft) has the rear portion unpainted.

The end of the war in Europe left the Royal Air Force with a gap in its inventory. The RAF had been mainly dependent upon American aircraft to fulfil its maritime requirements in Coastal Command, which had been returned or disposed of under the terms of the lend-lease agreement with the United States. This left the RAF without a maritime reconnaissance or long-range Air Sea Rescue (ASR) aircraft.

A number of Lancasters had been used by Coastal Command during the war for maritime reconnaissance, and whilst the crew had to rely on visual surveillance, the airframe proved suitable for the needs and stresses associated with long-range maritime patrol.

To fill the gap in the RAF's inventory, a number of Lancaster B. Mark IIIs from the RE, RF and SW serial blocks were converted by Cunliffe Owen for the Air Sea Rescue role. The conversion removed the mid-upper turret and fitted external attachments to hold a life boat suspended under the bomb bay. A window was added each side of the fuselage forward of the tail plane to improve

A well-used Lancaster GR.3, SW336 of No. 38 Squadron. The window in the crew entry door was not present in other marks of Lancaster.

© Osprey Publishing • www.ospreypublishing.com

This Lancaster B. Mark I (Modified) is one of the aircraft modified for use by the French Aeronavale in 1948. The aircraft is in all over blue with French roundels.

This colour image of a French Aeronavale Lancaster shows the later all over white scheme and roundel markings. Of interest is the lack of armament in the turrets. A further five were ordered by the French Aviation Civile et Commerciale (Civil and Commercial Aviation) in 1952. The aircraft were allocated the serials FCL01 to FCL05 and were delivered in early 1954.

visibility for observation. All the ASR conversions were fitted with H2S.

The RAF still struggled with its maritime role and in 1947 the lack of a General Reconnaissance/Maritime Reconnaissance aircraft led to the conversion of ASR Lancasters to General Reconnaissance (GR) machines. The GR machines were fitted with ASV radar in the H2S radome and a rear-facing camera was added in a pod under the rear turret. A change in role (and title) occurred in 1950 when the aircraft were retitled MR (Maritime Reconnaissance) aircraft, by which time Lincoln-style undercarriages were beginning to be found on some of these aircraft. The MR Lancaster would soldier on in the role until it was replaced by its younger sister the Shackleton.

## Lancaster Mark I (modified)

The Lancaster B. Mark I (modified) was in all technical respects identical to a standard B. Mark I. Under the terms of the Western Union Agreement of 1948, the French Aeronavale (Naval Air Arm) was to be equipped with surplus Lancaster B. Mark I and B. Mark VII aircraft modified to undertake maritime reconnaissance. The aircraft were converted at A. V. Roe and were all designated as Lancaster Mark I (modified). The modifications made to the aircraft reflected peacetime requirements. The dorsal turret was removed and



© Osprey Publishing • www.ospreypublishing.com

replaced with escape hatches. Extra fuel tanks were fitted in the bomb bay to extend the range of the aircraft to meet the needs of long maritime patrol missions. Advanced specialist equipment was fitted inside the aircraft to meet the needs of a maritime role. All the aircraft were allocated WK serials, the first WK-01 being handed over to the Aeronavale in January 1952, with a total of 58 aircraft being converted.

## Lancaster B. Mark IV and B. Mark V

| | |
|---|---|
| **Power:** | B. Mark IV: 4 Rolls-Royce Merlin 85 |
| | B. Mark V: 4 Packard Merlin 68A |
| **Dimensions:** | Span: 120ft |
| | Length: 78ft 3in |
| | Height: 17ft |
| | Wing area: 120ft |
| **Weight:** | All-up weight: 75,000lb (B. Mark IV) |
| **Performance:** | Maximum speed: 319mph at 12,500ft (B. Mark IV) |
| | Service ceiling: 30,500ft (B. Mark IV) |
| | Range: 1,470 miles (B. Mark IV) |
| **Armament:** | B. Mark IV: 4 .50 Browning machine guns in power-operated turrets: 2 in Boulton Paul 'F' nose turret and 2 in Boulton Paul 'D' tail turret. 2 20mm Hispano cannon in Bristol 17 mid-upper turret. |
| | 14,000lb bomb load. |

The Lancaster B. Mark IV and the B. Mark V were designed to meet Air Ministry requirement B.14/43. The requirement called for a large bomber to be powered by four two-stage, two-speed Merlin engines. The new aircraft was expected to be capable of operating at altitudes up to 35,000ft and to have an all-up weight of 70,000lb.

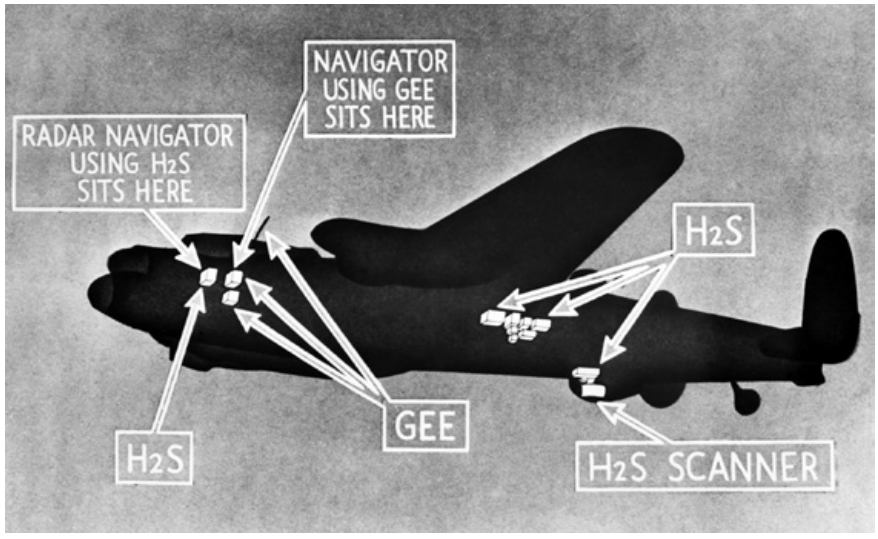
In response to B.14/43, Roy Chadwick proposed a modified Lancaster airframe. The fuselage was lengthened by inserting an 8ft-long section into the fuselage, and the nose was changed to a design based upon a modified nose trialled on Lancaster ED371, which accommodated the bomb aimer in a seated position rather than the prone position required in the previous marks of Lancaster, about which Bomber Command had expressed some dissatisfaction. The new nose replaced the bomb aimer's blister with a new framed, flat-panelled bomb-aiming blister, a new seat and improved equipment for the bomb aimer, as well as an improved turret. The Lancaster wing was extended with new outer wing sections, which increased the aircraft's wingspan to 120ft to enable the aircraft to meet the new performance requirements laid

Lincoln B2 RF398 at the RAF 50th Anniversary Royal Review, 7 June 1968.



© Osprey Publishing • www.ospreypublishing.com

This wartime Lancaster diagram shows the positions of the H2S and Gee equipment when fitted.




down in B.14/43. The fuel capacity of the wing tanks was also increased to 3,500 gallons.

The team at A. V. Roe gave consideration to the defensive armament of the Lancaster, and as a result the B. Mark IV and B. Mark V were equipped with a new nose turret, which mounted a pair of Browning .50 machine guns and a new tail turret that also mounted a pair of Browning .50 machine guns. Most importantly, the equipment of the dorsal turret was radically changed with the introduction of a new turret, which was positioned just aft of the wing trailing edge and mounted a pair of 20mm Hispano cannon. The new Lancaster packed quite a punch when she needed to defend herself.

In order to cope with the increased weight and offensive performance of the new mark of Lancaster the undercarriage was changed to a more robust design, and the bomb bay was modified.

The new design became the Avro Type 694, and was initially known as the Lancaster B. Mark IV with Merlin 85 engines and the Lancaster B. Mark V with Merlin 68A engines. The design had numerous changes to its predecessor, and whilst it resembled the Lancaster in general layout and still retained the large twin oval tail fins associated with the Lancaster, it was a very different machine. A. V. Roe wanted to change the name to reflect the fundamentally new design, but Bomber Command was keen to keep the Lancaster name. In June 1944 A. V. Roe suggested three possible new names for the Type 694, Sandringham, Stafford and Lincoln. J. D. Breakey ACAS (TR) commented that Lincoln was an appropriate name, as it not only reflected the current convention of naming bombers after cities in Britain, but also reflected the area in which the Lancaster had been operated by Bomber Command. The new name was officially approved in August. The Lancaster B. Mark IV became the Lincoln B. Mark I and the Lancaster B. Mark V became the Lincoln B. Mark II. Bomber Command would not get its new bomber until after World War II ended, even though it had been designed from the outset with service in the Far East in mind. The first prototype Lincoln PW925 first flew in June 1944, but events reduced the need to rush the new aircraft into service. In 1944 the successful Lancaster was viewed as perfectly adequate for operations in 1945, and production of Lancasters to meet Bomber Command's needs left no spare manufacturing capacity to dedicate to Lincoln production. The situation in



© Osprey Publishing • www.ospreypublishing.com

Europe and the Pacific was improving in favour of the Allies, and thus the need for a new bomber was reduced and its production became a low priority.

The need for large numbers of bombers disappeared after the end of the war, and many production orders for Lincolns were cancelled. Despite this, over 500 Lincolns were built, and the aircraft would serve the Royal Air Force well into the 1950s, some examples seeing service with Argentina and Australia. The last Lincoln retired from RAF service in 1963.

## Specialist equipment

It is necessary to discuss the specialist equipment fitted to Lancasters as a separate subject to the discussion of types since not all aircraft of one mark were fitted with the same specialist equipment; for example, not all B. Mark I aircraft were fitted with H2S. The section that follows briefly discusses some of the specialist equipment fitted to Lancasters.

### Gee

Gee was designed to assist navigation and to permit 'blind' bombing when the target was not visible to the bomb aimer. It relied on reception of signals from a series of ground stations, the master (A) and two slaves (B and C) along a 200 mile baseline. The time difference between receiving the signals from A and B and B and C were displayed on a unit in the aircraft. The navigator could calculate a ground position by referencing the display to a special 'Gee Chart', which gave a result accurate to within five and a half miles. Only a limited number of aircraft were fitted with Gee and typically led bomber streams to targets within the operating range of Gee, dropping their bomb load, which mainly consisted of incendiaries, to mark the target.

### Oboe

Oboe was the most accurate of the navigation systems used during World War II. It was needed because Gee could be, and was, jammed. Oboe was eventually jammed by the German defences too. Oboe was designed in 1941, based on two ground stations. The first, called 'cat', sent out a dot-dash signal, the second, called 'mouse', sent out a release signal, both signals operating on the same wavelength but at different pulse frequencies. A repeater in the aircraft responded to both frequencies, allowing each station to measure the aircraft's range. If on track, a steady tone would be heard by the pilot, allowing him to adjust his course if necessary. The system was only used in the target area.

### H2S

H2S was probably one of the most effective pieces of equipment used by Bomber Command during World War II. It consisted of an airborne interception radar that was fitted under the aircraft to point at the ground. Returning pulses were displayed on a cathode ray tube in the navigator's position, known as the Plan Position Indicator. H2S gave a radar map of the terrain that the aircraft was flying over and ahead of its path. The navigator was able to use the map to get a fix of where the aircraft was. H2S was not affected by weather, cloud or jamming and was completely independent of ground stations.

Lancasters fitted with H2S are extremely easy to identify. The H2S set was installed in a large, clear Perspex blister on the underside of the fuselage just aft of the bomb bay. The blister was sometimes painted in the underside colour for the forward two thirds of its length, with the rear third left clear. The first



© Osprey Publishing • www.ospreypublishing.com

This image of a Lancaster suggests a non-operational night. The circle in the blister is the bomb aimer's flat glass aiming panel. The two aerials on the underside are probably Gee or Oboe aerials. The lack of a blister aft of the bomb bay indicates that this aircraft is not fitted with H2S.

three Lancasters fitted with H2S were B. Mark IIIs, JB352, JB355 and JB356 in November 1943. The H2S system did have one fault; German night fighters could be guided to an H2S-fitted aircraft by 'listening' to the H2S emissions using Naxos sets.

### G-H and Loran

G-H was effectively an Oboe set working in reverse, the aircraft transmitting the signals that were received by mobile ground stations to give a fix. More aircraft could be on the G-H system simultaneously than could on Oboe, but accuracy depended heavily on the ability of the aircrew. The system was used first on the night of 3 November 1943 during a raid on Dusseldorf by 344 Lancasters, of which 38 were G-H-equipped. By October 1944, one third of No. 3 Group's Lancasters was fitted with G-H.

G-H-fitted Lancasters are also easy to identify, as their tail fins were painted in different colours to make identification easier for other aircraft so that non-G-H-fitted Lancasters could follow them to the target.

Loran was developed in the United States for long-range navigation over the sea. It used pairs of transmitting stations that gave the navigator a single position at a time, the navigator alternating between stations on 1-minute cycles to get a fix. It was used from 1944, when Gee sets were modified to allow them to switch between Gee and Loran.

### Electronic warfare

A number of electronic warfare systems were fitted to Lancasters in varying quantities during World War II. Some were restricted to aircraft of No. 100 Group, which was dedicated to electronic countermeasures against the German defence forces' equipment, whereas other systems were fitted to main force Lancasters.

Window was fitted to all main force Lancasters, and consisted of aluminium foil strips cut to precise lengths that would interfere with German ground radar by presenting multiple false targets. Window was initially dropped through the aircraft's flare chute by hand, but later a Window distribution box was fitted to the fuselage side. Another 'jamming' device was Tinsel, which was also fitted to main force Lancasters and involved fitting a microphone into one engine nacelle. From this, engine noise would be broadcast on the frequencies used by night fighters to communicate with their ground stations, making it impossible for the fighter to be guided to an intercept position. Mandrel was another device fitted to main force Lancasters, which produced a signal that saturated the German early-warning Freya radar sets.

Monica was a system fitted to main force Lancasters that consisted of a radar set facing aft of the aircraft to detect approaching night fighters. Lancasters fitted with Monica can be identified by an aerial located under the rear turret. Monica was removed when it was discovered that the German night fighter force had been equipped with Flensburg sets, which homed in on the Monica set's emissions.



© Osprey Publishing • www.ospreypublishing.com

Lastly, Airborne Cigar (ABC) was fitted to No. 101 Squadron aircraft only. It consisted of three transmitters and a receiver, and involved the addition of an eighth 'Special Duties' operator to the crew to operate the ABC set, who was a fluent German speaker. The operator listened to German night fighter force radio traffic and transmitted conflicting instructions to those given by the ground stations to the night fighter crews, although the German operators eventually got wise to Bomber Command's efforts. The ABC set was used later to broadcast a warbling note on frequencies on which the operator had observed night fighter radio traffic, making it impossible for the ground station and night fighter crews to talk to each other. Airborne Cigar-equipped Lancasters are easy to identify, the set requiring the fitting of three aerials, two on the top of the fuselage and one under the nose.

## OPERATIONAL HISTORY

Unfortunately it is not possible in this book to give a detailed account of every operation that the Lancaster was involved in during World War II. Limitations on space preclude anything other than a selective account; however, there are many excellent accounts of the Lancaster's career, individual raids and crews' accounts of their experiences, all of which have much to recommend them.

Avro Lancaster B. Mark I of No. 44 Squadron, 1942. 44 Squadron was the first to receive Lancasters. The condition of the paintwork on this aircraft suggests that it is new. The fuselage windows have not been painted over, which is another clue that this is an early aircraft. The crew of seven are lined up below the nose of the aircraft; the small white boxes carried by two of the crew are carrier pigeon containers.



© Osprey Publishing • www.ospreypublishing.com

## The Lancaster goes to war

The first squadron to receive the Lancaster was No. 44 (Rhodesia) Squadron based at RAF Waddington. The squadron received the Manchester Mark III prototype, BT308, on 9 September 1941 for air and ground crew training. The first three production Lancaster B. Mark Is, L5737, L5738 and L5741, arrived in December 1941. The squadron continued to receive new aircraft and undertook a thorough training programme to ready the crews for operations.

The Lancaster undertook its first operational raid when No. 44 Squadron despatched four aircraft, L7546, L7547, L7566 and L7549, on a gardening sortie (minelaying) off Heligoland on the north-west coast of Germany on the night of 3 March 1942. The raid was led by Squadron Leader John Nettleton (flying L7546), who laid his mines in the 'Yams' area, with Flight Lieutenant 'Nick' Sandford in L7568. The other pair (L7547 flown by Warrant Officer Lamb and L7549 flown by Warrant Officer Crum) laid their mines in the 'Rosemary' area. Each aircraft dropped four 'vegetables' (mines) from 600ft. All four aircraft returned safely to Waddington.

The first operation against a ground target undertaken by the Lancaster was on the night of 10 March, when No. 44 Squadron sent two aircraft as part of a 126 aircraft raid on Essen. The two pilots were Flying Officer Ball and Flying Officer Wilkins. Flying Officer Ball flew the first Lancaster over the target (L7536), arriving at 21:48 and bombing the target from 18,000ft. The load consisted of four small bomb containers (SBC) containing 94lb bombs, and 16 bundles of 'Nickles' G1 (incendiary bombs). Both Lancasters returned safely to Waddington, although four other aircraft on the raid were lost. The Lancaster had bared its teeth for the first time.

The second squadron to receive the Lancaster was No. 97 Squadron based at RAF Coningsby, which moved to RAF Woodhall Spa before commencing operations. The squadron took delivery of its first Lancasters in January 1942 and sent six Lancaster B. Mark Is to join 13 Manchesters detailed for a gardening sortie to the 'Willow' area. 'Willow' was an area stretching from Arcona to the River Dievenow in the Baltic. The Lancasters took off from Woodhall Spa in daylight, flying over the North Sea and Denmark to reach the target area at dusk, where they dropped their mines and returned to Woodhall Spa under the cover of darkness. All six returned safely, completing the Lancaster's first daylight operation.

The first loss of a Lancaster occurred on the night of 24 March 1942, when one of No. 44 Squadron's aircraft failed to return from a minelaying operation. The South African pilot, Flight Sergeant Lyster Warren, and all of his crew were killed.

The first joint effort by Lancaster squadrons occurred on the night of 25 March, when No. 44 Squadron and No. 97 Squadron despatched seven aircraft between them as part of a raid on Essen, which consisted of 254 bombers, a record number at the time. One of the Lancasters had to abort the raid and return home with technical issues, but the other six completed the mission and returned safely to base. Nine other aircraft were lost on the raid, including five out of 20 Manchesters taking part.

Seven Lancasters from the two squadrons took part in the next record-breaking raid, this time to Hamburg on the night of 8 April. It consisted of 272 aircraft, all returning safely.



© Osprey Publishing • www.ospreypublishing.com

Some of the early Lancasters were Gee equipped, and since targets in the Ruhr Valley were within the range of Gee, these aircraft were used as much as possible.

## Augsburg, 17 April 1942

With the entry of the Lancaster into service, Air Marshal Sir Arthur Harris, now commander in chief of Bomber Command, realized the potential of the new aircraft. It could fly higher than the Stirling, which was also limited in the offensive load it could carry due to the cellular design of parts of its bomb bay. It was as capable in many ways as the Halifax, which, like the Hawker Hurricane, would always remain in the shadow of its more famous cousin. The Lancaster and Halifax would see Bomber Command through the war, meeting most of the demands placed upon them, although the large bomb bay of the Lancaster – inherited from the Manchester's ability to carry a pair of torpedoes – gave more flexibility to the type of load it could carry.

The Lancaster gave Bomber Command an aircraft that Harris believed was capable of attacking any target in Germany at any time. By April 1942 the two squadrons equipped with the Lancaster were often flying together at low level, and rumours abounded that a special mission was on the horizon. The rumour gained strength when No. 44 Squadron, led by Squadron Leader John Nettleton, and No. 97 Squadron, led by Squadron Leader John Sherwood, undertook a special training flight, in which both squadrons independently flew to the south coast where they joined up to transit north and carry out a simulated 'attack' on Inverness. The crews began to believe that they were going to be detailed to attack German warships. The crews were briefed at their own bases on 17 April that they were to undertake a special raid, but not

A Lancaster taking off for Berlin. The port outer engine appears stopped due to the shutter speed used to capture this image at night. Noteworthy is the wear to the tips of the propeller spinners.



© Osprey Publishing • www.ospreypublishing.com

Lancaster B. Mark I R5689 (VN-N) of No. 50 Squadron showing the faired-in mid-upper turret and the unpainted fuselage windows. The pilot has the sliding canopy window open.

on German warships. The raid was to be an attack on the Maschinenfabrik Augsburg-Nurnburg Aktiengesellschaft factory at Augsburg, in southern Germany, which was producing diesel engines for U-boats. Augsburg would present a target 1,000 miles away, deep in occupied Europe, and one that would be the deepest that Bomber Command had penetrated into Germany at that time.

The plan called for six aircraft from each squadron to cross the Channel west of Le Havre and transit at low level south before turning east to pass south of Paris. They would then head towards Munich, as if the raid was targeted there, before turning north to attack Augsburg. The target called for precision bombing as it was a particularly small site, so it was decided that the attack would take place at low level in the last minutes of daylight, allowing the bombers to return under the cover of darkness, but that the trip outbound would be in full daylight. Each Lancaster was to carry only four 1,000lb general-purpose bombs with delayed fuses. Diversionary bombing raids and fighter sweeps were scheduled for the same afternoon to divert the Luftwaffe fighters from the Augsburg flight.

At 15:00 hours the 12 Lancasters took off from their bases and formed into four flights of three aircraft each. As they crossed the French coast, the diversionary raids had already brought up the Luftwaffe to intercept, but resulted in disaster when a group of fighters returning from an interception spotted the last section of Lancasters and gave chase. The fighters caught the rear flight of No. 44 Squadron, and immediately shot down the Lancaster flown by Warrant Officer 'Joe' Beckett DFM. The fighters turned on the second Lancaster, flown by Warrant Officer 'Bert' Crum DFM, which was attacked by six Messerschmitt Bf 109 fighters. Both port engines were soon hit and caught fire, and the Lancaster crashed into a wheat field. The last Lancaster in the section, flown by Flight Lieutenant 'Nick' Sandford DFC, was also shot down. The destruction of the section had only taken a few minutes, with all three Lancasters crashing within two miles of each other. (In fact Beckett's and Crum's planes crashed only 500 yards apart.)



© Osprey Publishing • www.ospreypublishing.com

The fighters turned on the lead section led by Squadron Leader Nettleton. Nettleton's number three, flown by Sergeant 'Dusty' Rhodes, was shot down. Both Nettleton's Lancaster and the number two, flown by Flying Officer 'Ginger' Garwell DFM, came under repeated attack and were hit a number of times by the fighters. Running short of fuel, the fighters were forced to turn for home before they could deliver the *coup de grâce*. The two flights of No. 97 Squadron remained completely unmolested, despite being only two miles away. The two surviving Lancasters of No. 44 Squadron continued to Augsburg without further incident.

The formations reached Augsburg, and Nettleton pressed home a determined attack. Garwell's aircraft was hit by flak on the run in to the target and crashed moments after releasing its bombs. No. 97 Squadron reached the target after Nettleton, by which time the defences were fully alerted. Sherwood led the first flight in to be met by a thick barrage of anti-aircraft fire. The flight all released their bombs, but Sherwood's aircraft was seen by the other two aircraft in the flight to explode on impact with the ground. The rear section, led by Flight Lieutenant 'Jock' Penman, began its attack, but the German gunners had by then established the exact line and altitude of the run in. The number two aircraft, flown by Flying Officer Ernest Deverill DFC, was hit repeatedly, putting the gun turrets out of action and causing the hydraulic oil in the mid-upper turret to catch fire and set fire to the starboard inner engine. The third aircraft also caught fire on the run in, although Warrant Officer Tommy Mycock DFC managed to keep his aircraft steady for long enough for the bombs to be released before the aircraft exploded.

The five remaining aircraft turned for the long journey home. They reached England without further incident, although Nettleton landed at Squire's Gate airfield near Blackpool after running short of fuel. The only survivor from the six No. 44 Squadron aircraft had returned safely. The four remaining No. 97 Squadron aircraft had all landed safely by midnight. Deverill's aircraft was written off immediately because of the amount of damage it had received.

The raid had been successful. The damage inflicted on the factory disrupted production for several weeks, but at a cost. Of the 85 men who had set out that afternoon, 49 were missing, although 12 survived to become prisoners of war. John Nettleton was awarded the Victoria Cross for his outstanding leadership of the raid; the rest of his crew were awarded DFCs and DFMs. Despite its success, the raid illustrated a point that the Luftwaffe had learnt during the Battle of Britain. The bomber was vulnerable to the modern monoplane fighter in daylight, and whilst formations of bombers would 'always get through', it would be at enormous cost. The USAAF (United States Army Air Force) would experience the same when it operated over occupied Europe in daylight, despite the greater defensive armament that its B-17 Flying Fortresses and B-24 Liberators had in comparison to the Lancaster.

## The 'Thousand Bomber' Raids, May and June 1942

By May 1942, Harris believed that a demonstration of the devastating power of a large bomber force would prove his reasoning for how the bombing war should be won. He planned a 'Thousand Bomber' raid against Cologne to take place on the night of 30 May.

The Lancaster equipped five squadrons by the time of the Cologne raid. No. 207 Squadron had re-equipped with the Lancaster and No. 83 Squadron had equipped with the aircraft at RAF Scampton. A fifth unit, No. 106



© Osprey Publishing • www.ospreypublishing.com

Squadron, had only just re-equipped with the Lancaster at RAF Coningsby under the command of Wing Commander Guy Gibson, so the Cologne raid was its first mission.

The plan was to send a stream of bombers to Cologne, all flying the same route at the same speed, to reduce the effect of the German night fighters by saturating the defences. It was also intended that the entire raid would be completed in 90 minutes. In order to mount the raid all available aircraft were called upon, including aircraft and crews from training units.

The raid eventually consisted of 1,047 aircraft, of which No. 5 Group provided 73 Lancasters, a record for the Lancaster at this point in the war (the previous Lancaster record being 21 aircraft sent as part of a raid on Warnemunde on the night of 8 May 1942). The raid turned Cologne into a sea of fire, with approximately 900 aircraft claiming to have bombed the city. The record number of aircraft in the raid also produced the greatest losses that Bomber Command had experienced in one night at that point. Forty-one aircraft were lost, only one of which was a Lancaster.

Harris ordered another 'Thousand Bomber' raid just two nights later, when 956 aircraft, including 74 Lancasters, attacked Essen. The city continued its reputation as a jinx on Bomber Command as it was difficult to find under thick ground haze, and results were below expectations. Bomber Command lost 31 aircraft, including four Lancasters.

The full force of Bomber Command was called into action once more on the night of 25 June when a force of 1,067 aircraft (including 100 from Coastal Command) attacked Bremen. The Lancaster force was now beginning to expand rapidly. A further two squadrons had been equipped with Lancasters since the previous all-out effort, No. 50 Squadron at RAF Skellingthorpe and No. 61 Squadron at RAF Syerston, both of which belonged to No. 5 Group. The Bremen raid saw a new record for the Lancaster, as 96 were available. Forty-eight aircraft were lost during the Bremen raid, but only one Lancaster failed to return from the 96 despatched.

The Lancaster force's efforts for Bomber Command were now increasing exponentially. The Bremen raid involving 96 Lancasters took place just three and a half months after four Lancasters had undertaken the first operation for the type.

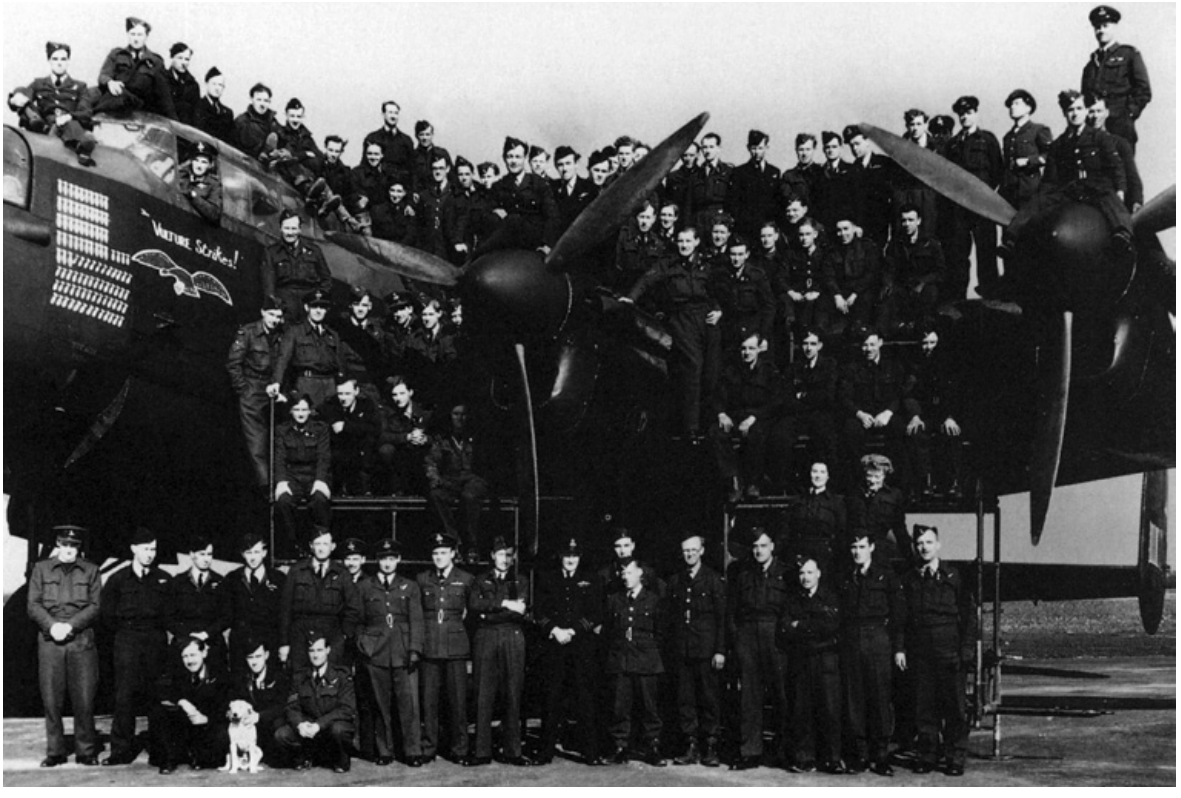
## The Pathfinders

Despite the increasing numbers of aircraft taking part in Bomber Command's operations, there was still work to be done. The RAF's heavy bombers, with the exception of the Lancaster, were showing faults. The Manchester was proving to be the most flawed, suffering a loss rate on average of 4.4 per cent (double that of the Short Stirling), and it appeared to be vulnerable to flak. The introduction of the Handley Page Halifax into service was costly, with the aircraft experiencing a 5 per cent loss rate up to June 1942, mainly due to night fighter activity. The Halifax suffered from unsatisfactory exhaust shrouds that made its engines stand out at night, making it easier for the night fighters to find it. The Stirling was suffering from its low operational ceiling and its inability to carry the larger bombs that Bomber Command was beginning to use.

The RAF had withdrawn its older and less-capable medium bombers, the Manchester, Whitley and Hampden, by July 1942. At the same time, the availability of Lancasters was increasing, an average of 50 being available each



© Osprey Publishing • www.ospreypublishing.com




A Lancaster B. Mark III PA995, with the personnel of No. 550 Squadron, after completing 100 sorties. PA995 was an Avro-constructed machine fitted with Packard Merlin engines when first built.

night, despite Harris being forced to transfer one Lancaster squadron to Coastal Command to help combat increasing U-boat activity in the Atlantic.

No. 44 Squadron was the first to move to assist Coastal Command, but Harris was keen that the squadrons and crews would not spend too much time away from Bomber Command and so a system of rotation for squadrons and crews was established.

The Lancaster continued the bombing offensive throughout July with a series of raids against Duisburg and Hamburg, as availability continued to increase. On the night of 31 July, 113 Lancasters took part in a raid on Dusseldorf.

Bomber Command continued to have difficulties with achieving satisfactory results. As a result, discussions took place were had about the creation of a specialist target-finding organization. Harris preferred to extend current tactics rather than creating a specialist force, but eventually relented and agreed to create a specialist Path Finder Force (PFF) to find and mark targets. Harris selected one of his best leaders, Group Captain Donald Bennett, to lead the force. The force was formed on 11 August, headquartered at RAF Warton. The force was initially made up of squadrons from each of the bomber groups, No. 7 Squadron (Stirlings) from No. 3 Group, No. 156 (Wellingtons) from No. 1 Group, No. 35 Squadron (Halifaxes) from No. 4 Group, No. 83 Squadron (Lancasters) from No. 5 Group and No. 109 Squadron from No. 2 Group (initially equipped with a mix of Wellingtons and Lancasters, which were replaced with Mosquitos when they became available).

The PFF began operations on the night of 18 August when the force marked Flensburg for the main force. The raid was not a great start for the PFF as the forecasted winds were in error and 16 of the 31 Pathfinders bombed north of the town. The second raid, on Frankfurt, was also disappointing since cloud



© Osprey Publishing • www.ospreypublishing.com

obscured the city, but the third attempt, on Kassel, proved more successful.

Bennett identified a number of issues, but it was only a matter of time before equipment and tactics would produce better results. The PFF was assisted by the availability of Oboe and H2S to equip the force by the end of the year. More pressingly, no Lancasters were available as replacements for No. 83 Squadron, as No. 49 and No. 9 squadrons were re-equipping with Lancasters. There were also issues with operating four different types of aircraft in the force. Operating altitudes and ground speeds differed, which needed to be taken into account, and it was expected that losses would be higher among the PFF as it was flying ahead of the main force and was likely to be engaged by the night fighter force over Europe, although this was less of a problem to the Lancaster crews than it was for the crews of the other types. This put a lot of pressure on the only PFF Lancaster squadron at the time. The personnel of No. 83 Squadron had a lot of pride in making the maximum number of aircraft available each night. The Lancaster began really to show its mettle as most of the squadron's aircraft were getting old and no replacements were available. Despite this the squadron carried on, often flying aircraft that were not technically serviceable, but the robust Lancaster did not let them down. The type would prove itself to be capable in other specialized roles as the war progressed.

## Operation *Chastise*, 16 May 1943

The Western Air Plan laid down that the German war machine should be attacked in the heart of its industrial heartland. The dams and reservoirs of this area were studied in great depth for attack before the war. It was realized by 1938 that the dams presented a difficult target, and that a specialized weapon would be needed with a suitable method to deliver it. The Mohne, Sorpe and Eder dams held the majority of water in the Ruhr, and were considered for attack with the Ennepe, Lister and Diemel dams. It was decided that the dams could be attacked in a future war and that the Mohne dam should be the priority target, as its destruction would not only seriously affect hydroelectricity generation but would also cause massive flooding in the valley, with associated destruction.

**E**

**OPERATION *CHASTISE*, 16 MAY 1943**

On the night of 16 May 1943, 19 Lancasters from No. 617 Squadron took off from RAF Scampton in three waves. Each aircraft carried a single Upkeep mine. The first wave reached its first target, the Mohne Dam, and attacked. The dam was breached by the fifth aircraft to attack, flown by Flight Lieutenant D. J. Maltby. The aircraft flown by Flight Lieutenant J. V. Hopgood was shot down during the attack, with only two of the crew surviving. The surviving aircraft which had dropped their bombs turned for Scampton, the others set course for the Eder Dam led by Wing Commander Guy Gibson (who had also released his bomb). The five aircraft met no opposition during their 14-minute flight to the Eder Dam, but struggled to find the dam among the steep valleys. Gibson eventually found the dam and fired red Very lights to guide the other four Lancasters to him. The Eder Dam was completely unprotected, no flak rising to meet the approaching aircraft.

The first to attack was Flight Lieutenant D. J. Shannon. Shannon made four abortive attempts; each time the crew failed to get to the correct height over the reservoir following the steep dive and sharp turn necessary to approach the dam. On the fifth attempt Shannon dropped his mine, which exploded against the dam wall. Shannon's Lancaster had all its landing lights switched on to help illuminate the hill beyond the dam. The aircraft climbed safely away from the target.

The dam was finally broken by the third aircraft to attack, flown by Pilot Officer L. G. Knight.

© Osprey Publishing • www.ospreypublishing.com

© Osprey Publishing • www.ospreypublishing.com

Wing Commander Guy Gibson and crew about to board Lancaster ED932 prior to Operation *Chastise*.

A civilian engineer had been working on addressing the need to breach the Ruhr dams for some time. Barnes Wallis was assistant chief designer at Vickers-Armstrong Aviation when war broke out in 1939. His initial idea consisted of a massive bomb to be dropped from a great height, which would destroy the dams through shock waves created underground. The idea would result in the Tallboy and Grand Slam bombs, but was not suitable for an attack on the dams. Wallis calculated that charges detonated against the dam wall were capable of weakening it and eventually causing a breach. He calculated that 6,000lb of RDX high explosive would be sufficient. The dams were protected by anti-torpedo nets, and so Wallis began his famous experiments in his garden, where he bounced marbles across the surface of water in a tub.

The bomb was initially spherical in shape, but tended to break up and weave off a straight course. The final Upkeep mine was a redesigned barrel shape, which was found to be more reliable. Trials were undertaken with a Wellington and the decision was taken to fit the bomb to the most capable aircraft that Bomber Command had available that was also able to lift the bomb and its release gear. The Lancaster was selected and A. V. Roe began work on the necessary conversions.

Bomber Command decided that a special squadron would be formed to undertake the raid, which, due to the limited time available for training, would have to be made up of some of the most experienced crews in the Command. The new squadron was to be in No. 5 Group and Air Vice Marshal The Hon. Ralph Cochrane chose one of his most experienced commanders, Wing Commander Guy Gibson, to command Squadron 'X', as it was initially known.

No. 617 Squadron was formed at RAF Scampton on 21 March, and crews began transferring into the new unit. Initially 617 borrowed Lancasters from other squadrons for training until its own 'Provisioning' Lancasters arrived. The squadron was ready to go by early May 1943.



© Osprey Publishing • www.ospreypublishing.com

Nineteen aircraft would be involved in the mission, codenamed *Chastise*, split into three sections. The first section of nine aircraft, led by Gibson, would attack the Mohne and if successful would move on to the Eder. The second section of five aircraft would attack the Sorpe and the third section of five would act as reserve, briefed to attack 'last resort' targets or the main targets if any had not been breached.

The mission was to be scheduled for when the water levels in the dams were at their highest, and the night of 16 May was chosen. The first wave took off from Scampton at 21:30. After crossing the Rhine, an aircraft in the second section, flown by Flight Lieutenant Bill Astell, was hit by flak from two positions, flying on for several miles before it became engulfed in flames. Gibson's section arrived over the Mohne dam unscathed. Gibson attacked first and hit the target despite intense ground fire, but did not breach the dam. Flight Lieutenant Hopwood attacked second. His aircraft was badly hit by ground fire during the run and the bomb was released late. The aircraft staggered away from the dam before exploding. Gibson then escorted Flight Lieutenant Martin's attack to draw some of the ground fire away, but the mine exploded early. Martin and Gibson then escorted Squadron Leader 'Dinghy' Young, who released perfectly. The mine exploded against the dam, but no breach appeared. The fifth aircraft, flown by Flight Lieutenant David Maltby, attacked but just as the Upkeep mine was released, the dam began to collapse. The seven remaining Lancasters circled the target to watch the deluge.

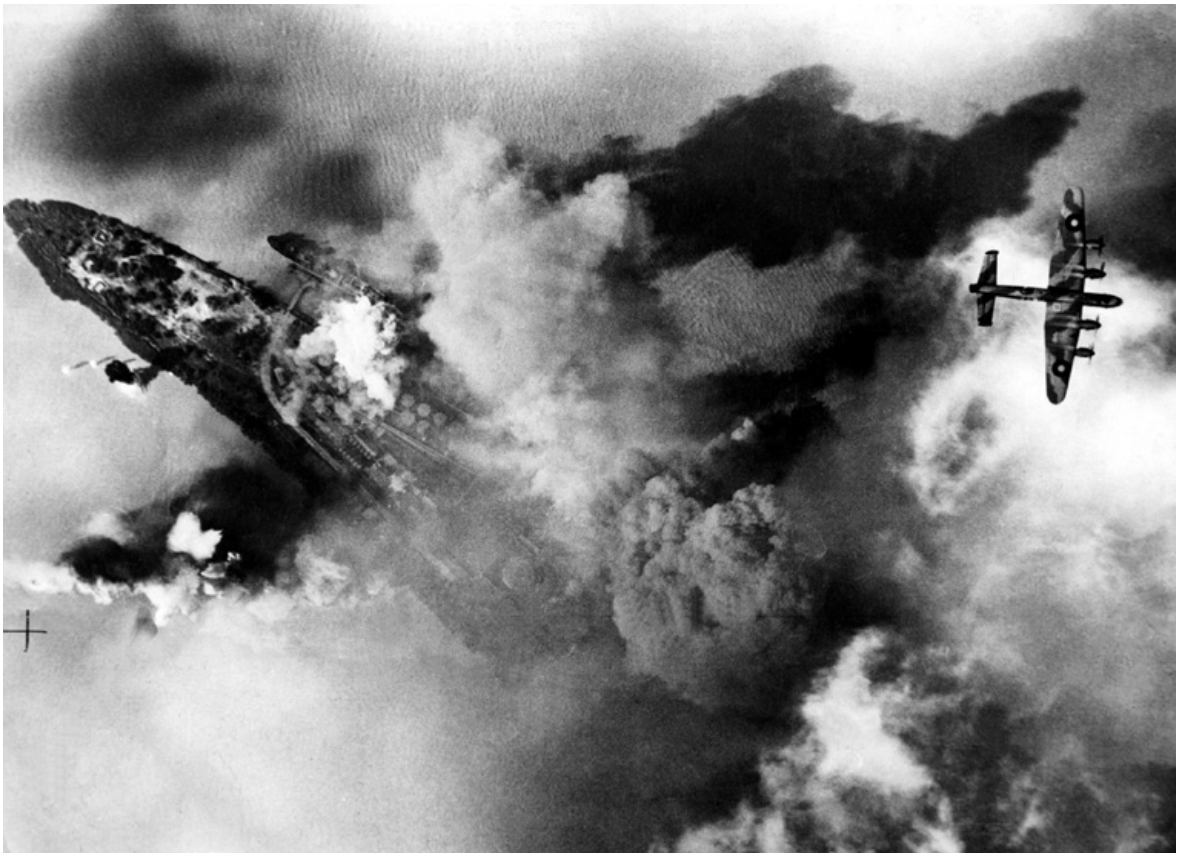
The remaining five aircraft that had not released their mines headed to the Eder dam, led by Gibson, whilst the others returned home. The crew arrived at the Eder to find it completely undefended, although the hilly terrain around the dam required not only great skill from the pilot, but also the full manoeuvrability of the Lancaster. The first to attack was Flight Lieutenant Dave Shannon, whose weapon hit the target and caused a slight breach. Next came Squadron Leader Henry Maudsley, whose weapon fell late, hit the dam wall, and exploded, catching the Lancaster in the blast. Maudsley's aircraft disappeared, but in fact survived the blast, a testament to the strength of the Lancaster, but was unfortunately shot down by flak on the way back to Scampton, none of the crew surviving. Last to attack was Pilot Officer Les Knight, whose mine was released perfectly, bouncing to the dam and sinking before exploding. The mine widened the breach in the dam and a great tidal wave swept down the Eder Valley.

The second wave had left later than Gibson's wave, and two aircraft were forced to return. Flight Lieutenant Munro returned after his Lancaster was damaged by flak and Pilot Officer Rice returned after his Upkeep mine was lost after clipping the sea when flying too low. Two other aircraft were not heard from again. Flight Lieutenant Barlow's aircraft crashed near the German-Dutch border, but no evidence currently exists to explain why. Pilot Officer Byers' aircraft was shot down by flak off the island of Texel on the Dutch coast. Flight Lieutenant Joe McCarthy pressed on alone to the Sorpe dam and attacked, damaging but not breaching the dam, before returning safely to Scampton.

The third wave, led by Pilot Officer Bill Ottley, crossed the Rhine, where Ottley's aircraft was hit by flak and exploded. The second aircraft, flown by Pilot Officer Burpee, was shot down by flak over Gilze-Rijen airfield. The third aircraft, flown by Flight Sergeant Anderson (who took off last), returned to Scampton with its Upkeep mine intact. His rear turret had become unserviceable necessitating large detours to avoid areas of heavy flak, and he had also



© Osprey Publishing • www.ospreypublishing.com



A Lancaster bombing Pauillac oil store and refinery at D'Ambes, 4 August 1944

encountered areas of mist making navigation difficult. As a result Anderson fell behind schedule, and with dawn only an hour away, reluctantly decided to return to Scampton. Only two aircraft were left to head to the Sorpe dam. Flight Sergeant Ken Brown attacked the dam and also hit the target without breaching it, returning safely to Scampton. Flight Sergeant Bill Townend attacked the Ennepe dam without success, and with daylight getting close raced back to Scampton, arriving safely at 06:15, the last to return.

*Chastise* had been successful and had once again demonstrated the capability of the Lancaster, with two of the main targets being breached. The losses experienced by the squadron to achieve this were excessively high, however. Eight of the 19 Lancasters despatched failed to return and 53 aircrew lost their lives.

## Operation *Gomorrah*, July to August 1943

In July 1943, following the 'Battle of the Ruhr', Bomber Command's attention turned to Hamburg. A ten-day campaign, between 24 July and 3 August, was launched, during which four very heavy and accurate attacks were mounted on the city. Hamburg was Germany's second largest city and was viewed as a priority target. It was also the country's largest port. The city and port were outside the range of Oboe but it was considered an ideal target for H2S.

The first raid on 24 July consisted of 791 aircraft, of which 347 were Lancasters. The Lancaster had become a major part of Bomber Command's effort. The raid was spread out over the city, but resulted in large amounts of



© Osprey Publishing • www.ospreypublishing.com

damage to the centre and surrounding districts. The raid marked another landmark; it was the first time that 'Window' had been used against the Wurzburg ground radar, and it caused great confusion among the ground defences.

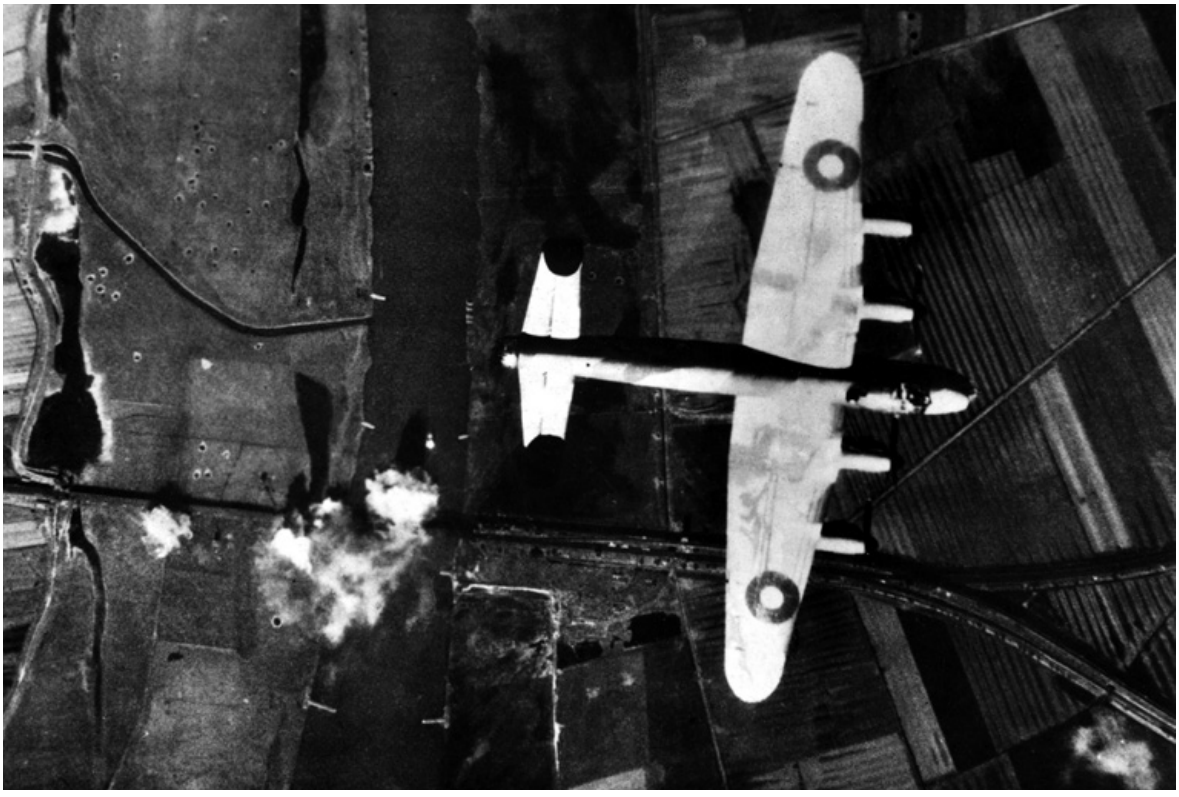
The force returned to Hamburg three nights later (with 353 Lancasters out of a force strength of 787). Weather conditions caused the concentrated bombing to develop into a firestorm lasting several hours. A third raid on the night of 30 July (with 340 Lancasters out of a force strength of 777) bombed the remaining areas of the city, causing heavy damage. The last raid, on the night of 2 August, was disrupted by bad weather, and many crews bombed alternative targets.

The Lancaster played a major role in the effort against Hamburg. Nearly half of the 3,000 sorties launched against the city were Lancaster sorties. Lancasters dropped around 10,000 tons of bombs on the city for the loss of 39 aircraft.

## A precision bomber

The Lancaster was selected by Bomber Command for use as a precision bomber. As the Allies gained air superiority over Europe, the Lancaster was able to operate by day, attacking 'precision' targets. A number of attacks were mounted on the V-weapon sites as part of the *Crossbow* campaign, many by day, starting on the night of 16 June 1944 against four sites in the Pas de Calais. The fear of Germany's new weapons was so great that an immense amount of effort was put into the bombing campaign against them. The largest raid consisted of 535 Lancasters out of a force of 739 aircraft detailed to attack seven V-weapon sites on the night of 24 June.

A Lancaster B. Mark I Special has just dropped a Tallboy bomb onto an unidentified railway bridge in occupied Europe.





© Osprey Publishing • www.ospreypublishing.com

The Germans had built heavily fortified sites in France to house V-1 and V-2 missiles and the V-3 supergun, which were impervious to the standard bombs in use by Bomber Command in 1944. A number of attacks had been mounted on the sites, which disrupted construction. Concerns about what the now completed bunkers might contain, especially if it was the V-2 ballistic missile, resulted in a need to destroy the bunkers before they could become fully operational.

A new weapon had entered Bomber Command's arsenal, which spelt the end of the bunker sites. The Tallboy bomb was the brainchild of Barnes Wallis and was built in two types: the medium Tallboy weighed 6 tons and the large Tallboy 11 tons. The only aircraft capable of carrying the new bomb was the Lancaster with its large bomb bay.

The V-2 bunker at Wizernes had been targeted before, but its heavily reinforced domed roof had proved impervious to attack. On 17 July a Lancaster raid dropped 12 Tallboy bombs on the site and although the dome remained intact, the bombs hit the site and undermined the facility, causing fatal damage, and resulted in its abandonment. The V-2 site at Watten was visited on 25 July by Tallboy-equipped Lancasters, which dropped 15 Tallboy bombs on the site, one of which broke open the rear of the structure.

The V-1 'Wasserwerke' bunkers were also put out of commission by Bomber Command raids, which included Tallboy-carrying Lancasters.

The last of the V-weapon sites was the Tausenfeussler supergun site at Mimoyecques, which was hit and destroyed by Tallboy-carrying Lancasters on 6 July. One of the Tallboys penetrated the gun port slab, destroying it, while three others crashed into the tunnels and exploded.

The Lancaster's new role as a precision bomber came to the fore in two more raids carried out late in the war. The Admiralty and Winston Churchill had remained concerned about the German battleship *Tirpitz*, which, despite being heavily damaged by X-craft attack and other air raids, including one Tallboy attack, still lurked in near Tromsø in Norway, where it was seen to pose a threat to the convoys to the Soviet Union and any possible amphibious invasion of Norway. It was decided that Bomber Command should attack the *Tirpitz* to knock her out of the war once and for all. Previous attacks had damaged the ship, but she still posed a threat. Bomber Command proposed to attack once more from bases in Scotland. Two squadrons who had earned a reputation for precision bombing were to be involved in the attack, No. 617 and No. 9 squadrons. The two squadrons' Lancasters were fitted with two extended range fuel tanks in the fuselage, and the nose and dorsal turrets were stripped out to save weight. The engines were also replaced with Merlin T-24s and paddle-bladed airscrews. Operation *Catechism* was scheduled for 12 November 1944.

The two squadrons, led by Wing Commander James 'Willie' Tait, took off at 3:25am, with 29 bombers heading towards Norway at 2,000ft to avoid German radar. The aircraft flew on into the dawn towards the rendezvous point at Tornetrask Lake in the mountains of Sweden. The aircraft circled until Tait signalled that the attack should begin, despite two No. 9 Squadron Lancasters not making the rendezvous. The aircraft turned north and approached Tromsø, where despite a warning of increased Luftwaffe fighter presence in the area, no sign of defending fighters was seen. The *Tirpitz* was sighted when the attackers were still 20 miles away. The peace of the scene was broken when the aircraft were five miles away and the *Tirpitz* opened fire upon them with her main armament.



© Osprey Publishing • www.ospreypublishing.com

Wing Commander J. B. Tait at Woodhall Spa 12 November 1944. Tait, who led the *Catechism* attack on *Tirpitz*, is seen here standing at the tail of a Lancaster. The turret is notable for having the centre glazing panel removed by the gunner to improve vision.

The 18 aircraft of No. 617 Squadron approached from the south-east with the sun behind them, in a gaggle spread between 12,650ft and 16,000ft. Tait approached at 13,000ft, his bomb aimer, Flying Officer Danny Daniel, guiding him towards the target. Ten seconds before the drop point a red light lit up on Tait's instrument panel, indicating that the auto-release mechanism was active, and as the Lancaster passed over *Tirpitz* the bomb swung away and went into a perfect descent. The bomb struck near the bow of the ship. The other aircraft released their bombs, one hitting the water close to the stern, two between ship and shore, others landing on the shore line. All 18 of 617's bombs had been released by 8:44am; No. 9 Squadron also released their ten bombs within seconds. None of the crews could see whether their bombs had hit the *Tirpitz* within the inferno that was raging on and around the ship, but she began to list and turned over seven minutes after the attack began.

The Lancaster proved itself extremely capable of delivering the Tallboy bomb on precision targets, but one more development would stretch the Lancaster to the limit. Barnes Wallis's 22,000lb Grand Slam bomb could only be carried by the Lancaster, but even Avro's mighty machine struggled to carry



© Osprey Publishing • www.ospreypublishing.com

the massive bomb. The specially modified Lancasters were issued to No. 617 Squadron, who mounted the first mission with the new weapon on 13 March. Twenty aircraft took off from Woodhall Spa on route to the Bielefeld Viaduct, among which were two Lancaster B. Mark I Specials flown by Group Captain Johnnie Fauquier (PD119/YZ-J) and 'Jock' Calder (PD112/YZ-S) carrying the only pair of live Grand Slam bombs in existence. The viaduct was obscured by thick cloud and so the force had to turn back. Fauquier and Calder diverted to RAF Carnaby upon return, as its longer runway could cope with the increased roll-out on landing that the weight of the bomb added. The mission was rescheduled for 14 March, but during pre-flight checks Fauquier's Lancaster developed technical faults and he tried to commandeer Calder's aircraft, who saw Fauquier approaching and took off before Fauquier could get close.

Calder reached the Bielefeld Viaduct without mishap and released his weapon from 12,000ft, becoming the first crew to drop the heaviest bomb in the world. The bomb undershot the viaduct by around 30 yards, but the shock waves generated by the explosion collapsed around 260ft of the viaduct.

## CONCLUSION

The Lancaster holds a special place in aviation history. It gave Bomber Command a capable bomber that, alongside the Halifax, filled the need for a heavy bomber from its introduction to operations in March 1942. A career that started with just four aircraft would see the aircraft become a key part of Bomber Command's inventory. The aircraft would perform an increasing large number of sorties in raids, increasing to a record of 796 Lancasters in a force of 805 aircraft that took part in the controversial raid on Dresden on the night of 13 February 1945.

The Lancaster would see service post war with Bomber Command and the French Aeronavale, although the story did not end there. The Lincoln, which

F

### OPERATION *CATECHISM*, 12 NOVEMBER 1944

The German battleship *Tirpitz* had occupied the minds of the Admiralty and Winston Churchill for most of the time it had been holed up in Norway. The British high command was worried that the ship might venture out to attack the convoys to Russia. The *Tirpitz* had been attacked numerous times, but had not been sunk. It had been heavily damaged by the attack on 15 September carried out by 26 Lancasters of nos. 617 and 9 squadrons, which took off from Russia carrying Tallboy bombs. The damage was assessed by the Kriegsmarine as being so serious as to require nine months' work just to make the *Tirpitz* seaworthy again. Despite this, the *Tirpitz* had not been sunk, and the RAF would try again.

The *Tirpitz* was towed to Tromsø on 15 October, bringing the ship within range of Lancasters if they took off from Scotland. The slow pace of the *Tirpitz*'s journey, intelligence reports and photographic reconnaissance all seemed to indicate that the *Tirpitz* was out of the war. The Admiralty in London was not convinced and requested a second attack, which would be codenamed Operation *Catechism*.

*Catechism* took place on 12 November 1944. The Lancasters of nos. 617 and 9 squadrons were once again allotted the task of dealing with the *Tirpitz*. At 0325hrs 29 Lancasters took off from Scotland, once again carrying Tallboy bombs, and set course for Tromsø. The aircraft reached the target and No. 617 Squadron attacked first. The first bomb was dropped at 0841hrs, and the last at 0844hrs, followed within seconds by all ten of No. 9 Squadron's Tallboys. The *Tirpitz* appears to have been hit numerous times and damaged by a number of near misses. The ship began to list and then rolled over.

© Osprey Publishing • www.ospreypublishing.com

© Osprey Publishing • www.ospreypublishing.com

No. 463 Squadron RAAF was one of the units involved in transporting prisoners of war home in May 1945. The ground crew are marking up RF270 (JO-V) with chalked slogans to greet the POWs.

saw service with the Royal Air Force until 1963, was essentially still a Lancaster, continuing the family's service.

Roy Chadwick and the design team at A. V. Roe had been considering a design for a large airliner that would satisfy the post-war demand for regular crossings of the North Atlantic for fare paying passengers and freight. Chadwick believed that it was vital that Britain should be able to play an important role in the post-war development of a network of air-routes. Chadwick began work on the design of his airliner in 1941, and based his new aircraft on the Lancaster. The project progressed on the basis that the aircraft should not only be suitable for civil aviation, but should also be capable of carrying troops. The mid-war period saw an urgent need for a transport aircraft that dovetailed with Chadwick's vision. The Type 685 was born, which used existing Lancaster construction jigs to speed up production of the aircraft, and was soon named the Avro York. The first prototype (LV626) was fitted with a standard Lancaster tail unit, wings and undercarriage married to a redesigned fuselage capable of carrying 40 troops. The tail unit was amended due to directional stability issues with the addition of a central fin, although the first prototype had shown such promise that the Air Ministry ordered four prototypes. The third prototype (LV633) became probably the most famous York. It was named *Ascalon* and was converted for VIP duties with No. 24 Squadron at Northolt. It was used by King George VI and Prime Minister Winston Churchill.

A. V. Roe was awarded a contract for the production of 200 Yorks, which would equip both the RAF's transport squadrons and, once the war ended, the civil airlines. Its potential as a civil airliner was recognized towards the end of the war when five aircraft were fitted to be capable of carrying 12 passengers, and were registered as G-AJGA to G-AJGE and delivered to BOAC. The York proved an excellent stopgap until purpose-built airliners



© Osprey Publishing • www.ospreypublishing.com

Avro Lancaster PD328 was converted into a Lancastrian airliner and named 'Aries'.

could be produced, and more than 250 Yorks were built. The York's greatest moment was probably its role as a cargo carrying aircraft during the Berlin Airlift during 1948 and 1949.

The team at A. V. Roe had also been working on a project to adapt the Lancaster to be the first passenger carrying airliner produced by Britain after the war. The aircraft was based upon the first production Lancaster sent to Canada to assist Victory Aircraft. It was fitted with fuel tanks in the bomb bay and stripped of its armament, and flown from Prestwick to Canada in 1942. It went through a further modification programme in Canada, which resulted in the fitting of nose and tail fairings, additional fuel tanks in the bomb bay and ten passenger seats plus additional windows in the cabin. The conversion would result in the Lancastrian Mark I, of which 60 were ordered for the RAF, half of which would be transferred to BOAC.

Avro Shackleton MR2 (WL742). The last of the Lancaster line, the Shackleton served with the RAF in both maritime reconnaissance and Airborne Early Warning roles until 1990.



© Osprey Publishing • www.ospreypublishing.com

This Lancaster is being used as a test aircraft for the Armstrong Siddeley Mamba turboprop engine, seen here mounted in the nose, during 1947.

The lack of a viable maritime reconnaissance aircraft resulted in the creation of the Lancaster A. S. R. 3 as an interim measure to see the RAF through its immediate post-war needs. A longer term solution was clearly required by the mid-1940s for an aircraft capable of undertaking long-range maritime reconnaissance missions that might last up to 18 hours. The requirement led to Air Ministry specification R.5/46, issued in 1947. The initial design was to be based upon a modified Lincoln, but it was soon realized that a completely new aircraft was required, which resulted in development of the Avro Type 696 based upon the Lincoln. The Type 696 was christened Shackleton. It was powered by four Rolls-Royce Griffon 57 engines driving six-bladed, contra-rotating propellers, and was 87ft in length with a 120ft wingspan. The crew of ten consisted of two pilots, two navigators, a flight engineer and five crew members who were responsible for other tasks during flight. The bomb bay was designed to carry up to 20,000lb of bombs or maritime stores. The first prototype (WV126) flew on 9 March 1949 from Woodford, the first 29 Mark I production aircraft being delivered to the RAF during 1950–51. The first RAF unit equipped with Shackleton was No. 120 Squadron at RAF Kinloss. The Shackleton would go on to perform Airborne Early Warning (AEW) duties with the conversion of some Mark II aircraft, which, due to problems with the RAF's replacement land-based AEW aircraft, would see service until 1990. The withdrawal of the last Shackleton from service saw the end of the Lancaster family's service with the RAF, apart from one solitary example, PA474, which still flies with the Battle of Britain Memorial Flight.



© Osprey Publishing • www.ospreypublishing.com

## FURTHER READING

There have been numerous technical studies written on the Avro Lancaster, and this bibliography is by no means exhaustive. There are also a large number of accounts written by Lancaster crews, all of which deserve close examination. Recent reprints of the pilots' notes also yield useful information on what the Lancaster was like to work with.


Angelucci, Enzo, *The World Encyclopedia of Military Aircraft*, Guild Publishing (1988).

Bateman, Alex, *No 617 'Dambuster' Sqn*, Osprey Publishing (2009).

Bishop, Patrick, *Target Tirpitz*, Harper Press (2012).

Bowyer, Chaz, *Avro Manchester*, Profile Publications (1974).

Brown, Capt Eric, *Wings of the Weird and Wonderful: Volume 1*, Airlife (1983).

Buttler, Tony, *British Secret Projects: Fighters and Bombers 1935-1950*, Ian Allen (2005).

Chorlton, Martyn, *Avro Lancaster Mk II*, Aeroplane Monthly (December 2014).

Cooper, Bryan, *The Story of The Bomber: 1914-1945*, Octopus Books (1974).

Garbet, M. and Goulding, G., *Lancaster*, Bookmart (1992).

Garbet, M. and Goulding, G., *Lancaster at War*, Ian Allen (1971).

Hannah, Donald, *The Avro York*, Profile Publications (1967).

Harris, Sir Arthur, *Bomber Offensive*, Pen & Sword Military Classics (2005).

Jacobs, Peter, *The Lancaster Story*, Arms & Armour Press (1996).

Lake, John, *Lancaster Squadrons 1942-43*, Osprey Publishing (2002).

Lake, John, *Lancaster Squadrons 1944-45*, Osprey Publishing (2002).

Mackay, R. S. G., *Lancaster in Action*, Squadron/Signal Publications (1982).

Moyes, Philip, J. R., *The Armstrong Whitworth Whitley*, Profile Publications (1967).

Overy, Richard, *Bomber Command 1939-45*, Harper Collins (1997).

Streatly, Martin, *The Aircraft of 100 Group,* Robert Hale (1984).

Sweatman, John, *The Dambusters Raid*, Arms & Armour Press (1990).

Wixey, Ken, *Forgotten Bombers of the Royal Air Force*, Arms & Armour Press (1997).

Yates, Harry, DFC, *Luck and a Lancaster*, Airlife Publishing (1999).

Zaloga, Steven J., *German V-Weapon Sites 1943-45*, Osprey Publishing (2007).




© Osprey Publishing • www.ospreypublishing.com

# INDEX


Page numbers in **bold** refer to illustrations and their captions.

Aeronavale (French Naval Air Arm) 38–39, **38**, 58
Aeroplane and Armament Experimental Establishment, Boscombe 7–8
Airborne Cigar (ABC) 43
Alliot Verdon Roe, Edwin 6
armament 5, 8, 11, 25
  Browning .303 machine gun **13**
  Browning .50 machine gun **D1**(30, **31)**, 33, 36, 40
  Hispano 20mm cannon 40
Armstrong Whitworth 14, 17, 24–25, 26
Armstrong Whitworth Whitley 5, **7**, 24
Astell, Flight Lieutenant Bill 53
ASV radar 38
Augsburg 45–47
Austin Motor Company (Austin Aero) 18
A.V. Roe and Company 6, 15, 40
Avro 679 7
Avro Lancaster A.S.R./G.R./MR. 3 37–38, **37**
Avro Lancaster B. Mark I **A4**(8, **9**), 18, **20**, 22–23, 28, 28–29, **D1**(30, **31**), **D3**(30, **31), 43**, 44, **46**
Avro Lancaster B. Mark I (FE) 34–36
Avro Lancaster B. Mark I (modified) 38–39, **38**
Avro Lancaster B. Mark I Special 32–34, **32**, **33**, **55**, 58
Avro Lancaster B. Mark II **14**, **B**(18, **19**), 25
Avro Lancaster B. Mark III **A2**-**3**(8, **9**), **28,** 28–29, 42, **49**
Avro Lancaster B. Mark IV 39–41
Avro Lancaster B. Mark V 39–41
Avro Lancaster B. Mark VI 34, **35**
Avro Lancaster B. Mark VII (FE) 36, **36**
Avro Lancaster B. Mark VII (interim) 36
Avro Lancaster B. Mark X 2132
Avro Lancastrian Mark I 61
Avro Lincoln **39,** 40–41, 58, 60
Avro Manchester 6–8, **A1**(8, **9**), **10**, 10–13, 12, 15, **C4**(26, **27)**
Avro Manchester Mark III 13–14, 15, 15–17, 44
Avro Shackleton 38, **61**, 62
Avro Type 680 14
Avro Type 683 Lancaster **14,** 15
Avro York **D4**(30, **31)**, 60–61

Battle of Britain Memorial Flight 62
Beckett, Warrant Officer 'Joe' 46
Bennett, Group Captain Donald 49, 50
Berlin 12–13
Bielefeld Viaduct 58
bomb bay **B**(18, **19)**, **20**, 21, 23, 25, **25**, 32
Bomber Command 4, 12–13, 36
bomber development 4–6, 6–7
bombs and bomb load 4, 5, **5**, 11–12, 23, **25**, 14, 46
  Grand Slam **32**, 33–34, **33**, 57–58
  Tallboy **55**, 56, 57
Bremen 48
Bristol Aeroplane Company 7
Bristol Beaufighter 26
Brown, Captain H. A. 'Sam' 7–8, 16
Brown, Flight Sergeant Ken 54

Calder, 'Jock' 58
Canada 30, 32
casualties and losses 44, 46–47, 48, 53, 54
Chadwick, Roy 6, 13–14, 14–15, 15, 16, 39, 60
Churchill, Sir Winston **D4**(30, **31)**, 56
civilian use 60–61, **61**
Coastal Command 5, 24, 37, 49
cockpit **15**, **16**, 20
Cologne 47–48
crew **12,** 18, 20, **43**
*Crossbow* campaign 55–56
Crum, Warrant Officer 'Bert' 46

Deverill, Flying Officer Ernest 47
Dobson, Roy 6, 15, 16
Douglas, Sholto 14
Dresden 58
Duisburg 49
Düsseldorf 42, 49

electronic warfare systems 42–43
engines 13, 29
  Bristol Hercules 13, 17, 23, **24**, 25, 26
  Packard Merlin 25, 28, 29, 32
  Rolls-Royce Merlin 13–14, **14**, 16, 17, 23–24, 25, 26, 28–29, 34, 39, 40
  Rolls-Royce Vulture 6–7, 7–8, 10, **10**, 11, 12
Essen 44, 48

Fairey Aviation Company 8, 17
Far East service 34–36, **36**
Fauquier, Group Captain Johnnie 58
Flensburg 49
Frankfurt 49–50
fuselage 20–21

G suffix 30
Garwell, Flying Officer Ginger' 47
Gee 36, **40**, 41, **42**, 45
G-H 42
Gibson, Wing Commander Guy 48, **E**(50, **51**), 52, **52**, 53

H2S 36, **37**, 38, **40**, 41, 41–42, 50
Hamburg 44, 49, 54–55
Handley Page 7
Handley Page Halifax 7, 13, 25, 26, 45, 48
Handley Page Hampden 4, **4**, 12, 13
Harris, Air Marshal Sir Arthur 5, 6, 10, 45, 47–48, 49
Heligoland 44
Hyde, Wing Commander Noel 10, 11

Ideal Bomber project 14

Kassel 50
Kiel 11
Knight, Pilot Officer L. G. **E**(50, **51**), 53

Lancaster Production Group 18
Loran 36, 42

Maltby, Flight Lieutenant D. J. **E**(50, **51**), 53
Mandrel 42
Manser, Flying Officer Leslie **A1**(8, **9**)
Maudsley, Squadron Leader Henry 53
Metropolitan Vickers 8, 17, 18
Monica 42
Mycock, Warrant Officer Tommy 47

name 17
Nettleton, Squadron Leader John 44, 45, 47

Oboe 41, **42**, 50
Operation *Catechism* 56–57, **57**, **F**(58, **59)**
Operation *Chastise* 50, **E**(50, **51**), 52–54, **52**
Operation *Gomorrah* 54–55

Pacific Theatre of Operations 35
Path Finder Force (PFF) 34, 49–50
Pauillac oil store **54**
precision bombing 55–58, **55**
production orders 17–18, 24–25, 28
prototypes **14**, 15, 15–16, 17, 24, **D2**(30, **31)**

radio countermeasures **D1**(30, **31)**
Rebecca 36
Royal Australian Air Force **24**, **60**
Royal Canadian Air Force 32
Ruhr dams 4, 29–30, 45, 50, **E**(50, **51**), 52–54, **52**

Sandford, Flight Lieutenant 'Nick' 44, 46
Shannon, Flight Lieutenant D. J. **E**(50, **51**), 53
Sherwood, Squadron Leader John 45, 47
Short Stirling 5, 13, 48
Siddeley, J. D. 6
Specification B.1/39 14
Specification B.9/32 4
squadrons
  No. 7 Squadron 34, 49
  No. 9 Squadron 50, 56–57, **F**(58, **59)**
  No. 24 (Commonwealth) Squadron **D4**(30, **31)**
  No. 35 Squadron **D3**(30, **31)**, 49
  No. 44 (Rhodesia) Squadron **A2**(8, **9**), **11,** 18, 22, **43**, 44, 45–47, 49
  No. 49 Squadron 50
  No. 50 Squadron **A1**(8, **9**), **46**, 48
  No. 61 Squadron 12, 25, 48
  No. 75 Squadron **A3**(8, **9**), **20**
  No. 83 Squadron 12, 47–48, 50
  No. 97 Squadron 11, 44, 45–47
  No. 101 Squadron **D1**(30, **31),** 43
  No. 106 Squadron 48
  No. 109 Squadron 49
  No. 115 Squadron **B**(18, **19)**
  No. 156 Squadron 49
  No. 207 Squadron 10–11, 47–48
  No. 300 (Masovian) Squadron **A3**(8, **9**)
  No. 550 Squadron **49**
  No. 617 Squadron **33**, 50, **E**(50, **51**), 52–54, **52**, 56–57, 58, **F**(58, **59)**
  No. 635 Squadron 34

tail assemblies 21, **C4**(26, **27)**
Tait, Wing Commander James 56–57, **57**
Thousand Bomber raids 47–48
Tiger Force 35, 36
Tinsel 42
*Tirpitz* 4, 56–57, **57**, **F**(58, **59)**
trials 16, 17, 25
tropicalization 34–36
turrets 14, **14**, 17, 18, **B**(18, **19)**, 20, 20–21, **20**, 22–23, 25, **C1–2**(26, **27)**, 32, 36, 40
  fairing **C3**(26, **27)**, **12**, 23, **46**
  rear **D1**(30, **31)**, **13**, 21, 23, 33, 36, 40, **57**
Type 464 'Provisioning' Lancaster **C5**(26, **27)**, 29–30, **E**(50, **51**), **52,** 52–54

undercarriage **11**, 21, 40
United States of America **D3**(30, **31)**
Upkeep mine **C5**(26, **27),** 29–30, 52

Vickers Wellington 4–5, **5**, 12
Vickers-Armstrong 18
Victory Aircraft Corporation 32, 61
V-weapon sites 55–56

Wallis, Barnes 4–5, 29, 33–34, 52, 56, 57
Window 42
windows 23, **43**, **46**
wings 21, 39–40




© Osprey Publishing • www.ospreypublishing.com

First published in Great Britain in 2015 by Osprey Publishing,
PO Box 883, Oxford, OX1 9PL, UK
PO Box 3985, New York, NY 10185-3985, USA
E-mail: info@ospreypublishing.com

Osprey Publishing, part of Bloomsbury Publishing Plc

© 2015 Osprey Publishing Ltd.

All rights reserved. Apart from any fair dealing for the purpose of private study, research, criticism or review, as permitted under the Copyright, Designs and Patents Act, 1988, no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, electrical, chemical, mechanical, optical, photocopying, recording or otherwise, without the prior written permission of the copyright owner. Enquiries should be addressed to the Publishers.

© Osprey Publishing. Access to this book is not digitally restricted. In return, we ask you that you use it for personal, non--commercial purposes only. Please don't upload this ebook to a peer--to--peer site, email it to everyone you know, or resell it. Osprey Publishing reserves all rights to its digital content and no part of these products may be copied, stored in a retrieval system or transmitted in any form by any means, electronic, mechanical, recording or otherwise (except as permitted here), without the written permission of the publisher. Please support our continuing book publishing programme by using this e--book responsibly.

Every effort has been made by the Publisher to secure permissions to use the images in this publication. If there has been any oversight we would be happy to rectify the situation and written submission should be made to Osprey Publishing.A CIP catalogue record for this book is available from the British Library

Print ISBN: 978 1 4728 0944 5
PDF ebook ISBN: 9781472809452
ePub ebook ISBN: 9781472809469

Index by Alan Rutter
Typeset in Sabon
Originated by PDQ Media, Bungay, UK

Osprey Publishing is supporting the Woodland Trust, the UK's leading woodland conservation charity, by funding the dedication of trees.

**www.ospreypublishing.com**

## PHOTOS

All photos in this book are courtesy of Cody Images.

© Osprey Publishing • www.ospreypublishing.com